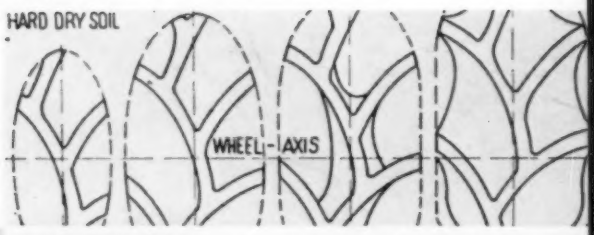
MAY 1958

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

Fundamentals of Soil Compaction Under Tractor Tires | 276



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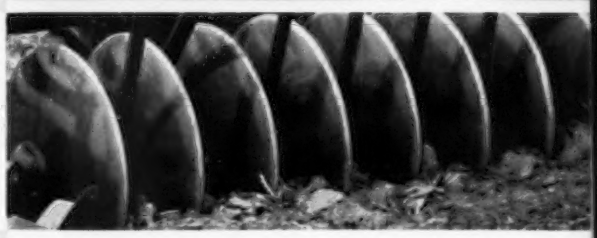

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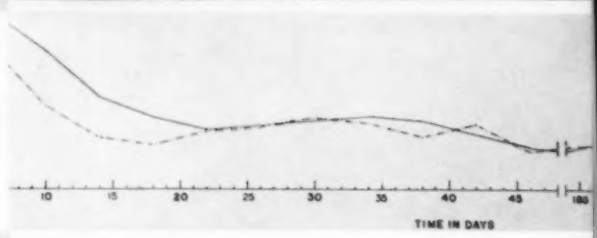

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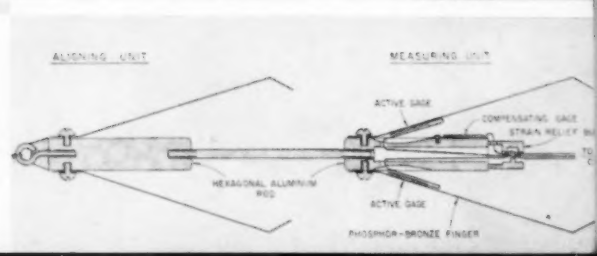

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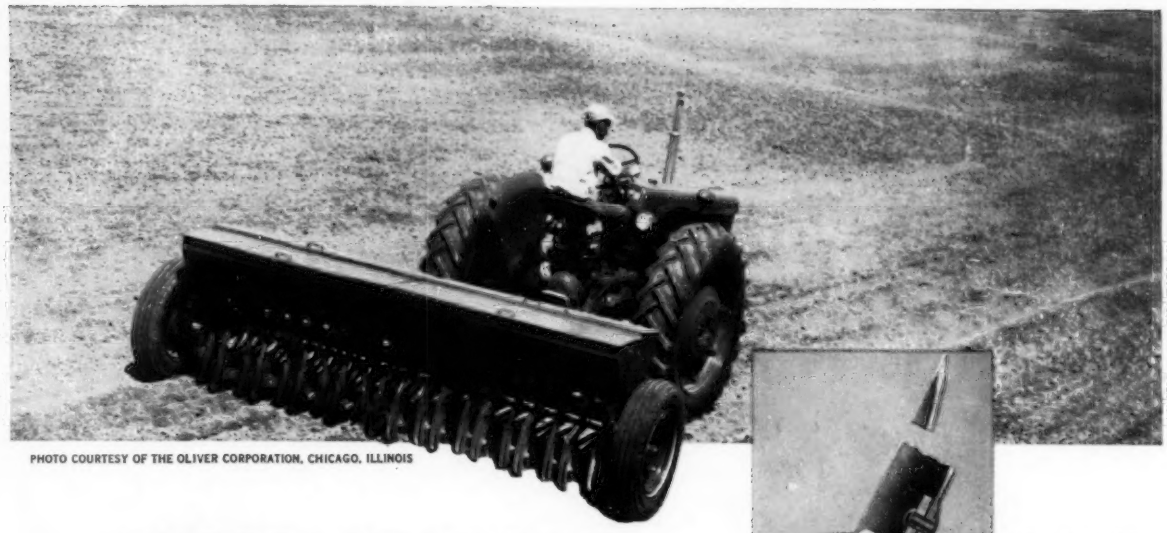


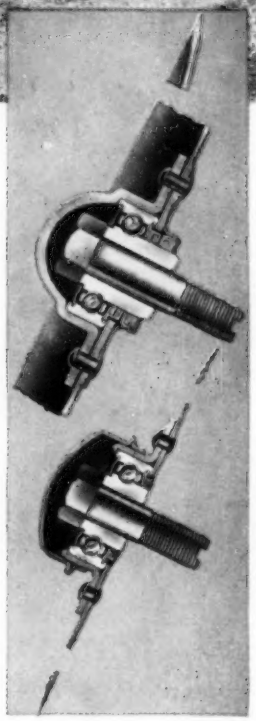
PHOTO COURTESY OF THE OLIVER CORPORATION, CHICAGO, ILLINOIS

THESE LIGHT-DUTY DISC BALL BEARINGS NEED NO SERVICE!

That's right! There's no "downtime" for relubrication or other periodic attention!

These New Departure Disc Bearings are efficiently sealed to shut out dust, dirt, moisture and *wear*. Deep-grooved races give *extra stability* where misaligning loads occur. Their machined bores fit standard-size machine bolts to give you economical, simplified mounting.

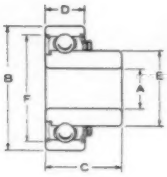
Count on New Departure, as do other leading farm implement manufacturers, to help you add *sales appeal* and *design simplicity* to your products.



Left, a Type I bearing in single-mounted grain drill disc. Recommended where extremely contaminated conditions require extra sealing precautions.

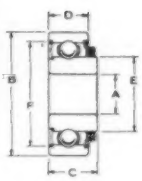
Left, a Type II Light-Duty Disc Bearing mounted in double-disc furrow opener, uses standard ⅜" machine bolt.

PRINCIPAL DIMENSIONS



TYPE I

Type	Bearing	Bore A	O.D. B +.0000 −.0005	Inner Ring Width C ±.005	Outer Ring Width D ±.005	Inner Ring Outside Dia. E	Outer Ring Inside Dia. F
I	87504A16	.632 .626	1.8504	1.125	.5512	1.1585 1.1575	1.634
II	87504U	.632 .626	1.8504	.686	.5512	1.1585 1.1575	1.634



TYPE II

NEW DEPARTURE

1908–1958 GM FORWARD FROM FIFTY

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

(For more facts circle No. 1 on reply card)

A shining bright new SURGE!

NOW...

A Looking-Glass Finish Outside...and...INSIDE!

This new Surge Bucket won't wash itself, but it does make it mighty easy for you to see that it is clean . . . because inside, it's looking-glass bright.

It is so slick and smooth and so clean and shining that it is hard for milkstone to get any kind of a toe hold. You won't be able to find the seam in the heavy, durable wall of genuine 18/8 stainless steel.

This Surge ad is running in farm publications. We thought you might be interested, too.

Copyright 1958 — Babson Bros. Co.

. . . and even better cow milking!

Men who have used the Surge to milk a lot of cows for thousands of milkings tell us that this new 1958 model bucket milker does reach all quarters a little better —that it gets more irregular quarters well handled and that they can milk faster.

Genuine Surge TUG & PULL milking has been good cow milking for 35 years—now it is even better . . . so . . . 1958 is a good year to switch to Surge.

Your Surge Dealer may not be able to deliver your new Surge buckets the day you want them, but production is rolling—you won't have long to wait.

BABSON BROS. CO.

2843 W. 19th Street • Chicago 23, Illinois

ATLANTA • DALLAS • KANSAS CITY • MINNEAPOLIS
SACRAMENTO • SEATTLE • SYRACUSE • TORONTO

Surge

(For more facts circle No. 6 on reply card)

Agricultural Engineering

Established 1920

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JAMES BASSELMAN, *Editor and Publisher*

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New Director of Tillage Laboratory

AN IMPORTANT personnel change took place recently when A. W. Cooper was appointed director of the U.S. Department of Agriculture, National Tillage Machinery Laboratory, Auburn, Ala., following the retirement of M. L. Nichols, past-president of ASAE.

M. L. NICHOLS

Mark Nichols has announced his retirement after serving the field of agriculture during a long and distinguished career as farmer, agronomist and agricultural engineer. He was born in Bellevue, Ohio, January 24, 1888, where he completed his high school training. He received a B.S. degree in agricultural engineering in 1912 from Ohio State University, an M.S. degree in soils from Delaware University in 1916, and an honorary Sc.D. degree for soil research from Clemson College in 1937. From 1917-1919 he held the position of agricultural engineer at Virginia Polytechnic Institute and was head of the agricultural engineering department of Alabama Polytechnic Institute 1919-1936 until he accepted the position of regional engineer with the Soil Conservation Service, USDA. He became chief of research in 1938 and continued in that capacity until 1953 when he was made director of the Tillage Laboratory.

A. W. COOPER

Dr. Nichols' leadership in his professional field has resulted in impressive accomplishments for agricultural engineering. His extensive study on the physical properties of soil as related to tillage design resulted in his development of the famous Nichols Terrace, approved by farmers in many sections of the country. He developed the program of research in soil dynamics at Auburn and planned and helped set up the Tillage Laboratory. The department of agricultural engineering at Auburn also was organized under his supervision. His valuable contributions to the soil research program of TVA, the rural electrification program in Alabama, and as a member of President Hoover's Committee on Home Building and Home Ownership represent other of his accomplishments as an agricultural engineer.

Dr. Nichols has been an active member of ASAE. Besides holding the office of president of the Society, 1946-1947, he has served on the Council and on numerous committees. He organized the Southeast Section and was elected its first chairman. In 1934 he received the McCormick Gold Medal and was awarded Life Fellowship in ASAE earlier this year.

Dr. Cooper also has been an active member of ASAE since 1939. He has served as a member of committees on mulch tillage and technical data, as vice-chairman of the Southeast Section, chairman of the Alabama Section, and presently is chairman of the committee on soil compaction.

Arthur Cooper was born in Fairfield, Ala., in 1918, and received both B.S. and M.S. degrees from Alabama Polytechnic Institute where he served as assistant professor of agricultural engineering until 1945. After a tour of duty with the U.S. Navy he was engaged in farm electrification research at Purdue University from 1946 until 1949 when he became project supervisor in a joint study with Alabama Polytechnic Institute on seedbed preparation, infiltration rates, runoff, soil loss and erosion control. Since 1953 he has been assistant director of the Tillage Laboratory, except for two years in which he carried on joint studies between the Laboratory and Michigan State University while working on a Ph.D. degree. Among other professional honorary ratings he has twice been listed in Who's Who — in 1948 in the Midwest and 1956 in the South and Southwest.

How Mufflers Made of Armco ALUMINIZED STEEL Help Sell Tractors

Because most farm equipment dealers warehouse their tractors in the open, unsightly rust appears on the muffler soon after the tractors have been started a few times by prospective buyers. This is just one reason why it pays to equip tractors with mufflers made of Armco ALUMINIZED STEEL Type 1.

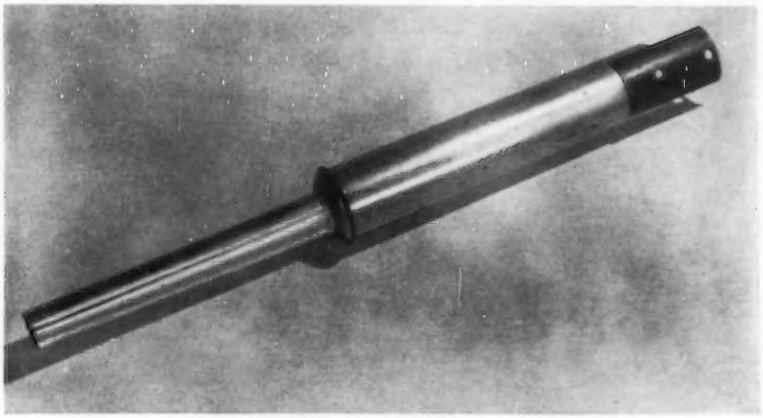
This special aluminum-coated steel has excellent resistance to a combination of heat and corrosion. Because the coating is applied by a continuous hot-dip process, the aluminum doesn't melt off when mufflers heat up. In fact, heat makes the coating take a firmer grip on the base metal.

LASTS LONGER

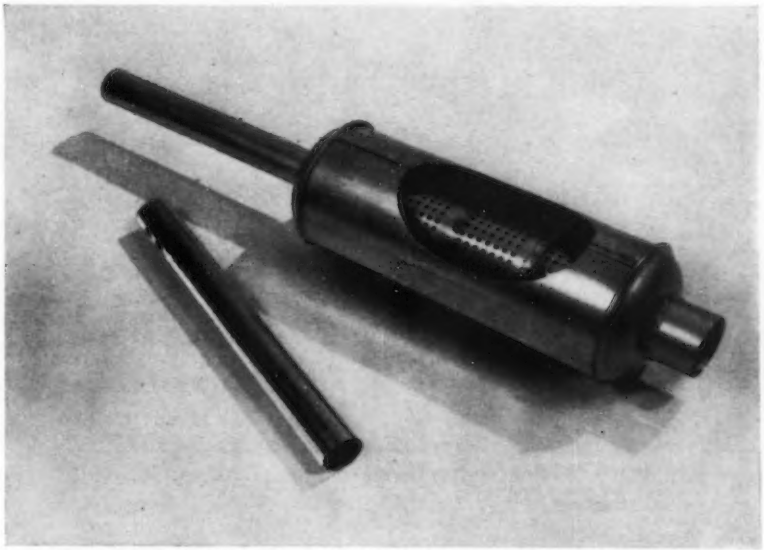
Here's another reason why mufflers made of ALUMINIZED STEEL pay dividends. Seven-year road tests on passenger cars show that ALUMINIZED STEEL mufflers outlast cold-rolled steel mufflers at least two to one. In a rugged truck muffler service test by a motor freight carrier, ALUMINIZED STEEL outperformed ordinary steel mufflers five to one on a mileage basis.

Tractor mufflers made of this special steel will last longer . . . assure more satisfied customers . . . help build dealer loyalty. The result: more sales, more profits.

For complete information on ALUMINIZED STEEL or for the names of manufacturers of ALUMINIZED STEEL mufflers, just write us at the address below.



ALUMINIZED STEEL *muffler with mounting bracket.*



ALUMINIZED STEEL *muffler with tube and baffles exposed by cutaway.*

ARMCO STEEL

ARMCO STEEL CORPORATION, 2078 Curtis Street, Middletown, Ohio
Sheffield Division • Armco Drainage & Metal Products, Inc.
The Armco International Corporation

(For more facts circle No. 7 on reply card)

PRECISION WASHERS

For automatic transmissions and similar bearing applications

FEDERAL Mogul

Solid steel or bronze; steel faced with babbitt or copper-lead, or copper-lead on *both faces*. Flat, spherical or special shapes. Grooves, holes, nibs, scallops or lugs. O.D. 1″ to 6″. Wall thickness: solid, .028″ to .141″; bimetal, .034″ to .141″. Cold rolled for heavy-duty. Large capacity. Complete engineering service.

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FEDERAL-MOGUL-BOWER BEARINGS, INC., 11081 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

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The good name of your machine is LINK-BELT's first consideration . . . TRADE MARK . . . and quality should be your first consideration in the chain you buy

New Holland Manure Spreader uses Link-Belt steel detachable chain on apron conveyor and AG roller chain and sprockets for transmitting power.

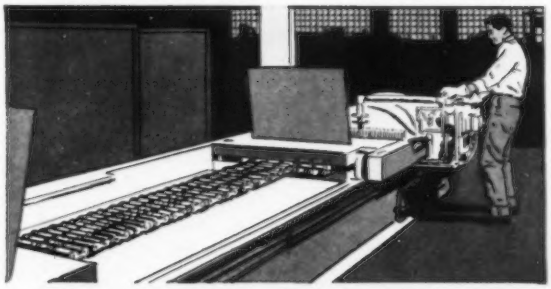
Be sure you specify drive and conveyor chain with

the quality your design deserves

Use LINK-BELT chain . . . built to top farm machine standards as determined by field and lab tests

LINK-BELT'S recommendation of the best drive or conveying chain for your machine is based on experience gained in field tests under actual working conditions. And Link-Belt is in the best position to make unbiased proposals because our line of chain, sprockets and attachments is *complete*. Horsepower, loading, speed, impact—every requirement can be met to enable your machine to maintain rated performance and efficiency throughout its life.

Yes, Link-Belt's unmatched facilities, experience and services are your best assurance of quality chain, properly applied. Next time you're considering a drive or conveyor application, our chain specialists will be glad to work with your engineers. For facts and prompt service, call your nearby Link-Belt office.



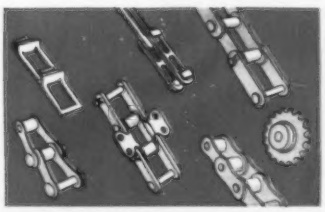
ACCURATE MANUFACTURE — Modern specialized machines allow the economies of large-scale production. Continuous inspections safeguard tolerance and finish of every link of chain. With these extensive facilities, Link-Belt has ample capacity to meet your production schedules.

LABORATORY CONTROL — Every chain bearing the Link-Belt trade mark meets rigid uniformity specifications. Our modern laboratory continuously explores new refinements to increase chain life. It is located at the world's largest plant manufacturing drive and conveying chain.

LINK-BELT

THE SYMBOL OF QUALITY — LB — LINK-BELT

CHAINS AND SPROCKETS



COMPLETE LINE of agricultural chains, sprockets and attachments permits cost-saving specialization — offers the right chain for all conveyor and drive needs.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,843

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OWATONNA Implement cuts

Dayton BSI* V-Belts provide dependable power under severe two way flexing

Saving time and reducing manpower needs for hundreds of farmers all over the country, the Owatonna Self-propelled Windrower, first of its kind on the market, is powered by Dayton V-Belts.

Making a single operation of the old mowing and side rake method, the center delivery Owatonna implement is saving farmers up to 60% in time. Chief reason is the elimination of the back swath on the first two rounds. Cutting wastes are eliminated, too, because new fields can be opened without knocking down any of the hay or grain.

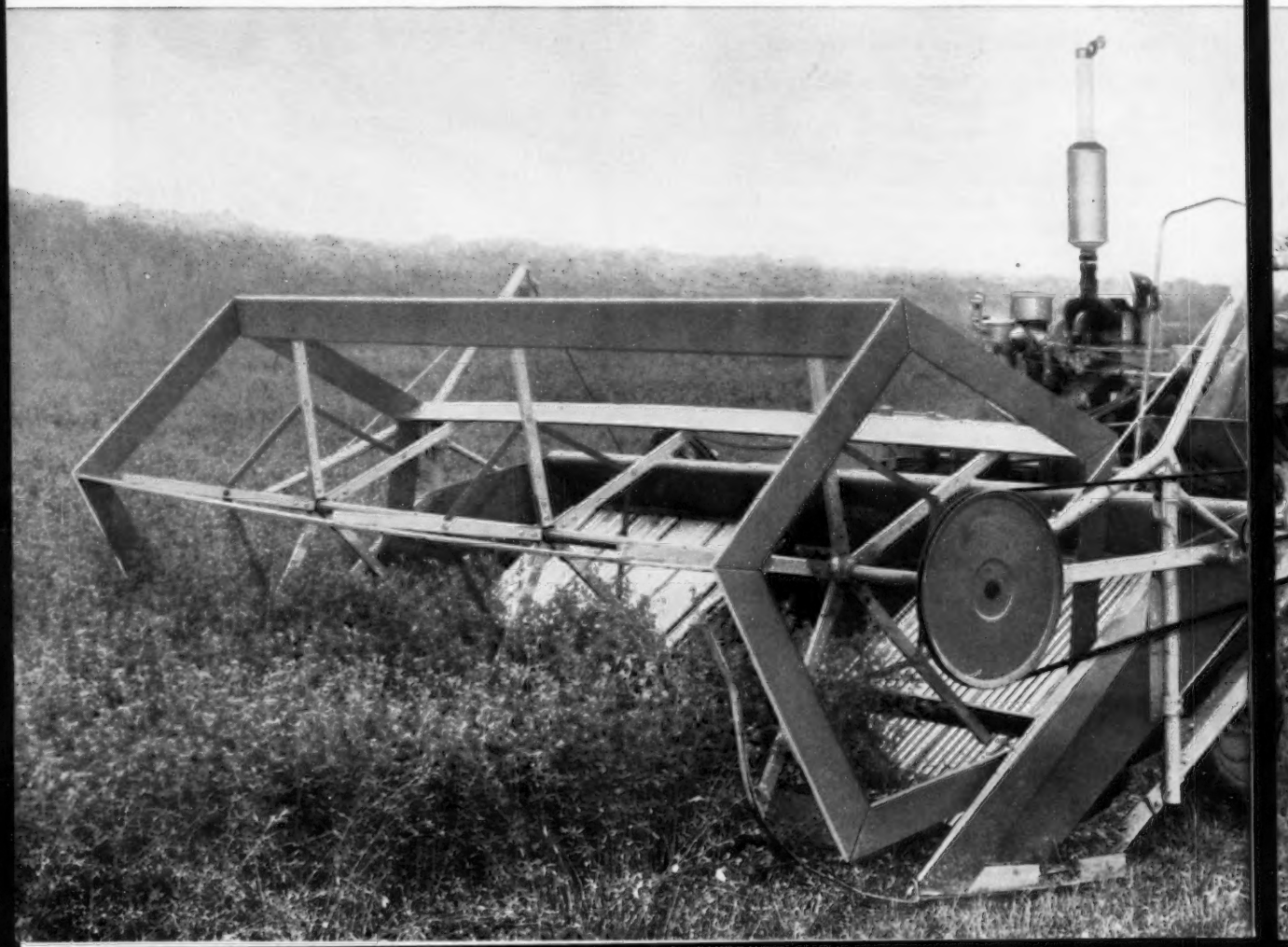
One hurdle confronting O.M.C. engineers during developmental stages was the method of keeping proper tension on the V-Belt drive for all positions of the reel.

The simplest solution was an idler, but they felt this would not give satisfactory V-Belt service life. Backbends approaching 180° were required, and no ordinary V-Belt will hold up under that kind of punishment.

The Dayton V-Belt Engineer, when asked for a recommendation, suggested use of Dayton BSI V-Belts which are specifically designed to give two way flexibility over long periods of time.

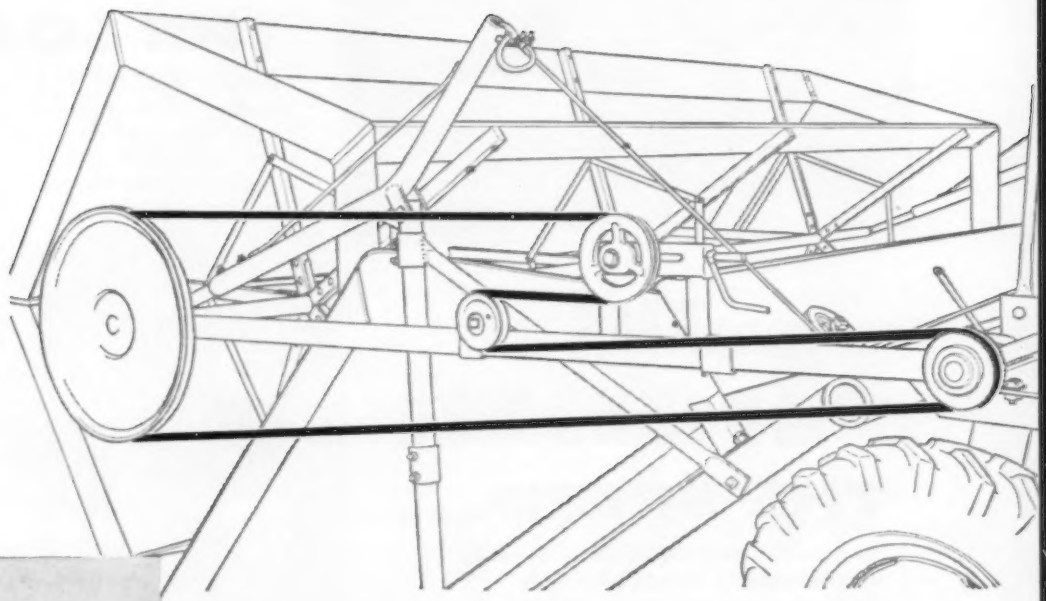
Owatonna Engineers testing Dayton BSI V-Belts were more than satisfied with performance. The V-Belts were approved and installed on all Owatonna Self-propelled Windrowers. In the field they have exceeded expectations for trouble-free service.

For help in solving your simplest or most difficult power transmission problems consult the Dayton Agricultural Engineer. Write The Dayton Rubber Company, Agricultural O.E.M. Division, Dayton 1, Ohio.



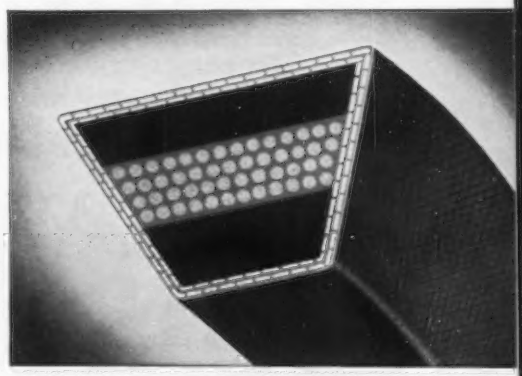
windrowing time up to 60%

Speeds of 2-8 mph permit the Self-propelled Owatonna Windrower to adjust to all crop and field conditions. Two planetary transmissions with individual wheel drives give greater maneuverability. Center delivery allows cutting close to fences and around wet or green areas, produces fluffy windrows every time.



Steady, dependable power transmission to the reel at any height is provided by Dayton BSI V-Belts. Idler properly adjusts belt tension. Note the extreme backbend. Even under bends approaching 180° around small diameter idlers Dayton BSI V-Belts give exceptional service.

Dayton BSI V-Belt is specifically designed to give two way flexibility. Extra pliable compounds on both sides of the strength section and highly resilient fabric covers assure long life under the most difficult service conditions.



*Back Side Idler

Dayton Rubber

First in Agricultural V-Belts

Agricultural Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Minneapolis, Moline, New York, San Francisco and St. Louis

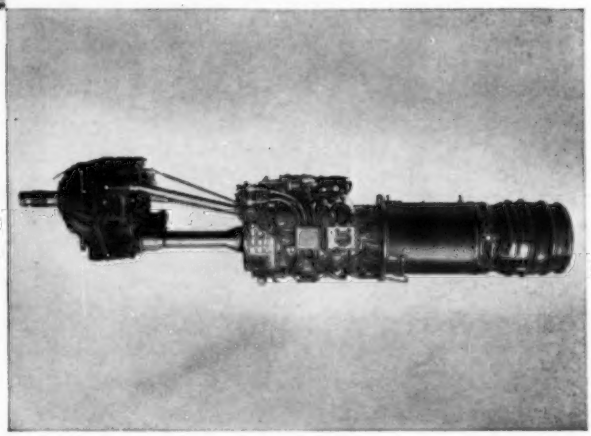
(For more facts circle No. 33 on reply card)

THE HEAVIER THE LOAD...

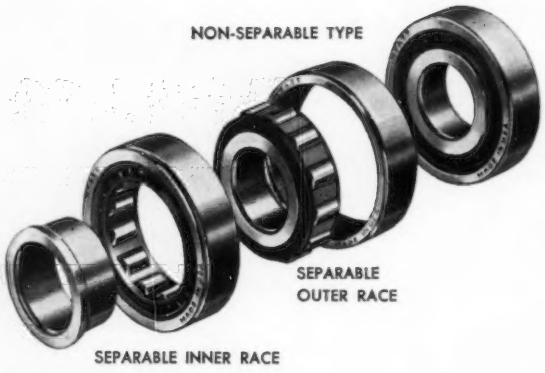
the more you need HYATTS . . . because nothing can touch the straight cylindrical roller bearing for downright load-carrying capacity and longer life in rugged applications like this heavy-duty tractor.

THE HIGHER THE SPEED...

the more you need HYATTS . . . because stringent controls and superior steels assure smoother, trouble-free performance in high speed applications like this powerful Allison turbo-prop engine.



THE MORE YOU NEED *Cylindrical* HY-ROLL BEARINGS



If you're like many engineers today, often faced with the problem of fitting heavier loads and higher speeds into smaller housings, HYATTS are your answer! You'll find your problems solved with bearings like the shouldered-race HYATT Hy-Rolls that handle rugged radial loads along with a surprising amount of thrust. You can save added space, too, by eliminating the outer or inner race of separable HYATTS, and operating the rollers directly on the hardened and ground shaft or housing bore. Check your nearest HYATT Sales Engineer for recommendations on your particular problems today! Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Pittsburgh; Detroit; Chicago; and Oakland, California.

THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

1908–1958 GM FORWARD FROM FIFTY

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

(For more facts circle No. 10 on reply card)

Report to Readers . . .

RUBBER HOSE PROVIDES GUARD FOR TRACTOR POWER-TAKE-OFF SHAFT

A report on a test of a p-t-o safety guard, made recently by the NIAE in England, will be of special interest to engineers and others interested in obviating the operational hazards of the power-take-off shaft. The guard used in this test consists of a length of convoluted rubber hose and two conical sheet-metal endpieces. This provides a loosely fitting sheath which rotates freely on the p-t-o shaft. Each endpiece is fitted with a thrust bearing to prevent it from binding on the universal joints when the convoluted hose is compressed as the shaft shortens during turns. While the guard may rotate freely with the p-t-o shaft, it will stop rotating as soon as pressure is applied to it. . . . . The NIAE concludes from its test that, when used in conjunction with rigid master guards on tractor and implement, this new p-t-o safety guard should afford good protection to an operator, provided it is correctly fitted to an appropriate shaft and is properly maintained. . . . . The type of guard supplied for the NIAE test was found suitable only for standard Hardy-Spicer p-t-o shafts; however, it appears that only minor modifications will be required to adapt this guard to other types of p-t-o shafts, including shafts incorporating a safety clutch.

ENGINEERS DEVELOP SIMPLE DEVICE TO MEASURE DRAINAGE FLOW RATES

As part of a research study of flow rates from tile drainage systems, engineers in the Minnesota agricultural experiment station were confronted with the need for a measuring device capable of producing a continuous record of a wide range of flows. Their subsequent experiments led to the development of what they call a slotted-tube flowmeter. The device consists primarily of a slotted tube mounted vertically at or near the end of a discharge pipe with the slot directed upstream. . . . . The water level in the slotted tube, measured from the bottom of the pipe, is used as an index of discharge. This "head" corresponds closely to the specific energy of flow in the pipe, that is, depth plus velocity head.. . . . The merits of the slotted-tube flowmeter are briefly these: (1) It is relatively simple, having no moving parts subject to binding, sticking, or wear; (2) it is not sensitive to minor deviations in fabrication and installation, other than the diameter of the test pipe; (3) it will measure a wide range of discharges, including low flows, with good accuracy, and (4) its head loss is small. The authors' account of the development and application of this device is given elsewhere in this issue.

PREFAB UNITS MAY REDUCE DAIRY BARN CONSTRUCTION AND REMODELING COSTS

That is the way it looks now to agricultural engineers at the University of Wisconsin. These engineers have designed prefabricated stanchions and mangers that can be installed more rapidly and cheaply, or removed or replaced easily. This would permit farmers to shift interior arrangements to take advantage of new equipment, to change over to loose housing, to use the barn for storage or other types of livestock, or to provide for wider or narrower stalls. The concrete work required in connection with prefab units would cost less, since fewer forms would be needed, thereby effecting savings in form lumber, concrete and labor. . . . . The floor of a barn designed for prefab units would be practically level, except for the gutters. Stall units would be set in holes provided for them when the concrete floor was poured, and when the stalls are in, the holes would be filled with sand and covered with concrete. Pipes supporting the stanchions would also serve as water lines and as vacuum lines for milking machines. Also, pipes used

in building stanchions would be held together with pressure fittings which require no threading, or they would be welded together - in either case, facilitating assembly. . . . . Mangers might be built of metal, plastic, fiberglass, or wood and attached with hooks to the front of each stall. . . . . In brief, the Wisconsin engineers believe prefab units will make the dairy barn a more flexible building that can be altered easily to meet new conditions and requirements.

"MOUSE" MEASURES THE EXTENT OF SUBSURFACE DRAIN DETERIORATION

"Measuring mouse" is an appropriately descriptive term for a strain-gage-actuated measuring instrument, developed by a USDA agricultural engineer in cooperation with agricultural engineers of the New York agricultural experiment station. The "mouse" has primary application in the study of the deterioration of subsurface drains, especially bare earth channels (mole drains) and plastic or cement-reinforced earth channels. The device is made in two sections, the front section serving only for channel alignment; to the rear section (measuring unit) are attached the strain gages to give a picture of the channel cross section as the "mouse" is pulled through a drain by means of a wire. This unique device is described elsewhere in this issue.

ENGINEERS SAVE WOOD IN NEW DESIGN OF A TRUSSED RAFTER

Three engineers in the Oklahoma agricultural experiment station have developed a new design for a lightweight trussed rafter that utilizes wood more efficiently and that can be quickly assembled without precision cutting or fitting. This new rafter compares favorably in strength and stiffness with trussed rafters of conventional design, and it is easier to assemble than the latter which uses 2-inch dressed lumber and requires splice plates and special connectors at the joints. . . . . The new lightweight rafter is assembled from 1-inch rough or undressed lumber, and the members are so arranged that all the joints have sufficient overlap for gluing and nailing without the need for gussets or splice plates. The use of undressed lumber avoids wastage of wood. Also, use of the 1-inch instead of the usual 2-inch thickness of material in making up the new rafter provides greater stiffness for a given amount of wood. . . . . This new trussed rafter appears to be specially suited to such farm building needs as livestock and poultry shelters, hay and machinery storages, on which the roof covering is to be applied to spaced nailers.

HORIZONTAL SILO NUDGES UPRIGHT TYPE ON THE QUALITY OF SILAGE

Probably the most serious obstacle to the acceptance and success of horizontal silos has been the excessive spoilage and low quality of silage put into structures of this type. However, USDA researchers say that some of their recent findings may change this situation. . . . . The cause of spoilage has been due mainly to too much surface of the stored material being exposed to the air, also to the fact that often the silage is not adequately packed. The result is extensive spoilage of surface silage and leaching of soluble nutrients. It has been found possible, however, to reduce these losses to a minimum by covering the surface of the silage with plastic sheets. Providing and maintaining a firm weight over the entire silage cover proved to be one of the biggest factors in eliminating costly spoilage of the top layer of silage. The researchers say that silage saved from spoilage by the best means of covering is worth about three times what a tight cover costs. . . . . One thing this more favorable showing for the horizontal silo will do, will be to make it more competitive (in farmer acceptance) with the upright type. However, both types are likely to do very well from the standpoint of acceptance, for each has strong points in its favor.

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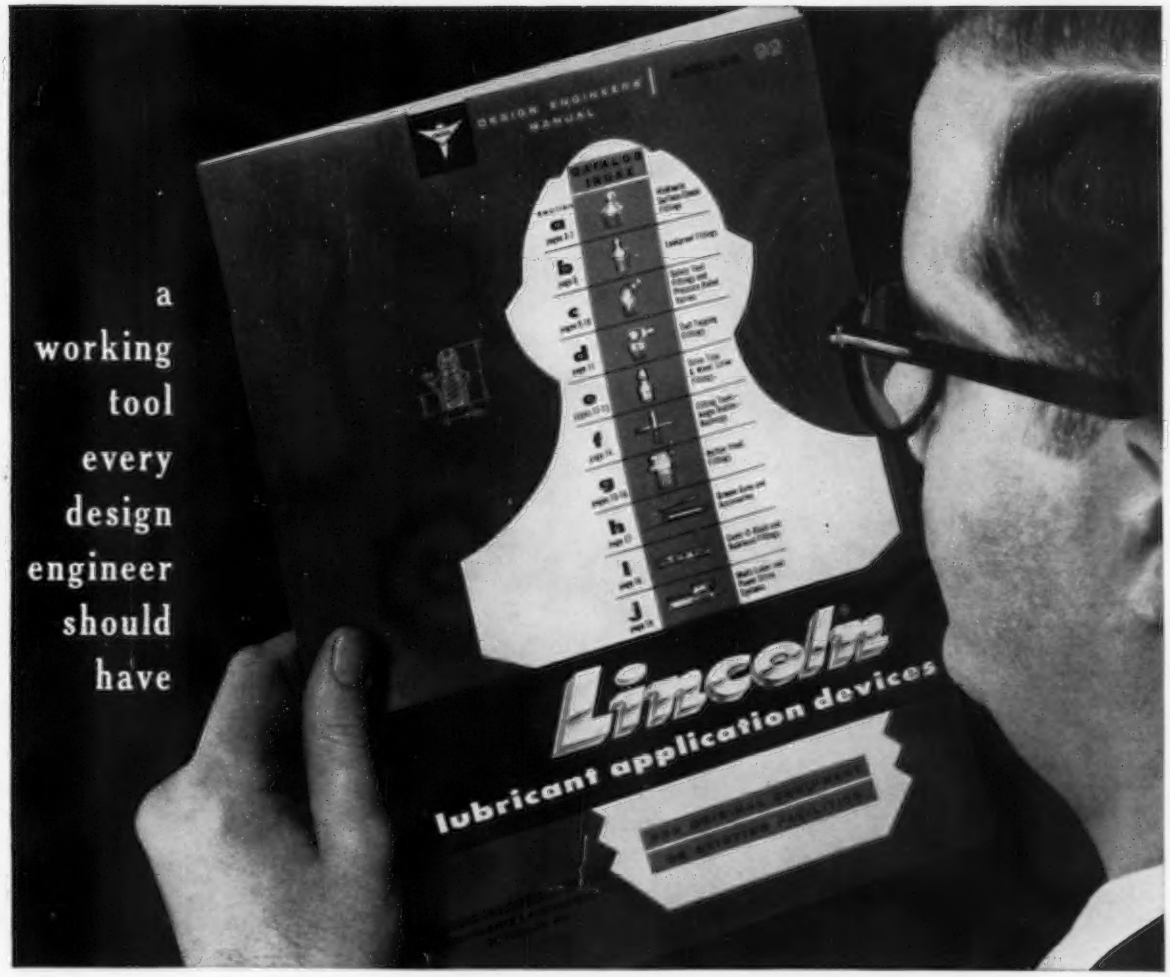

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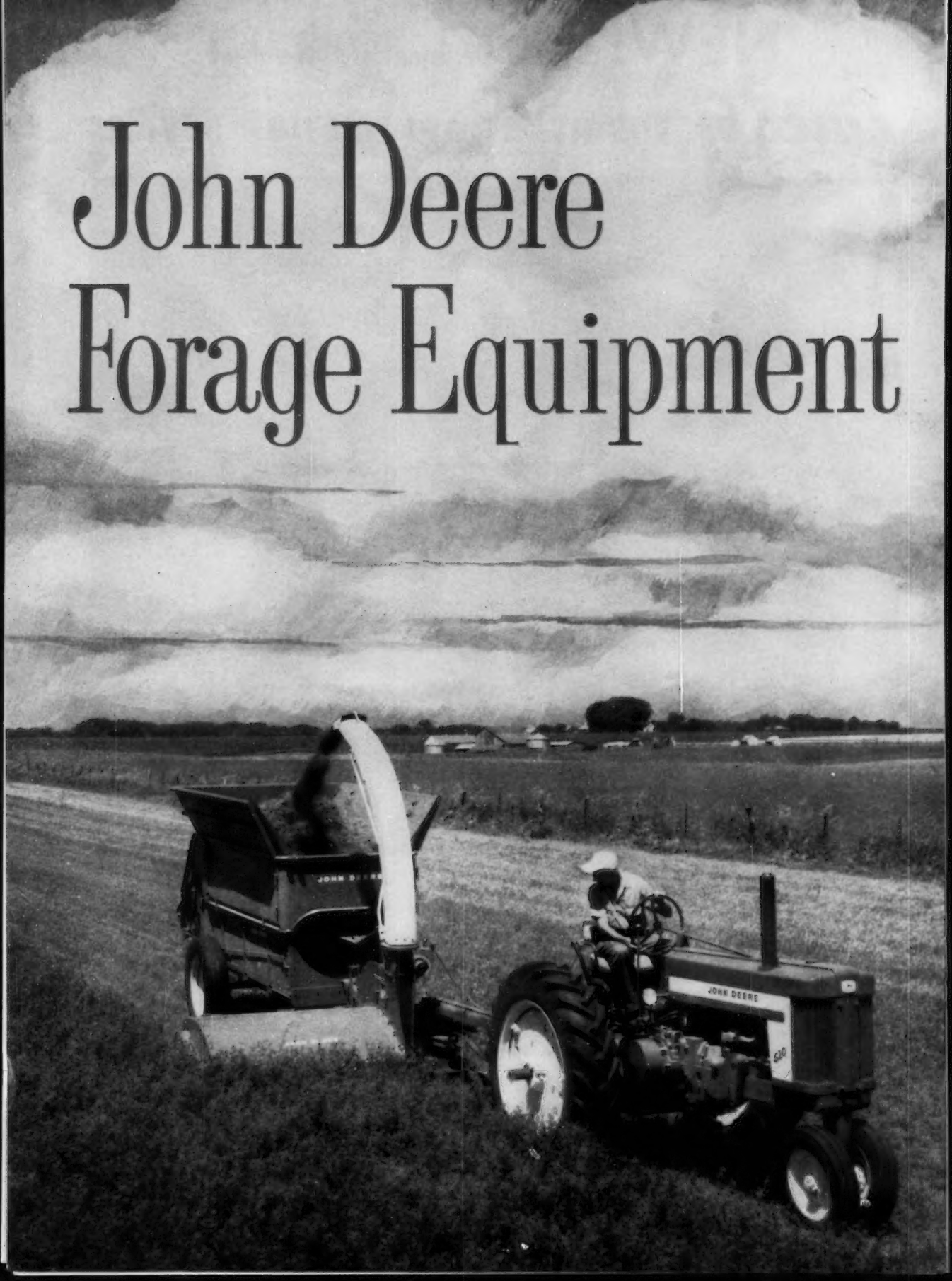
John Deere Forage Equipment



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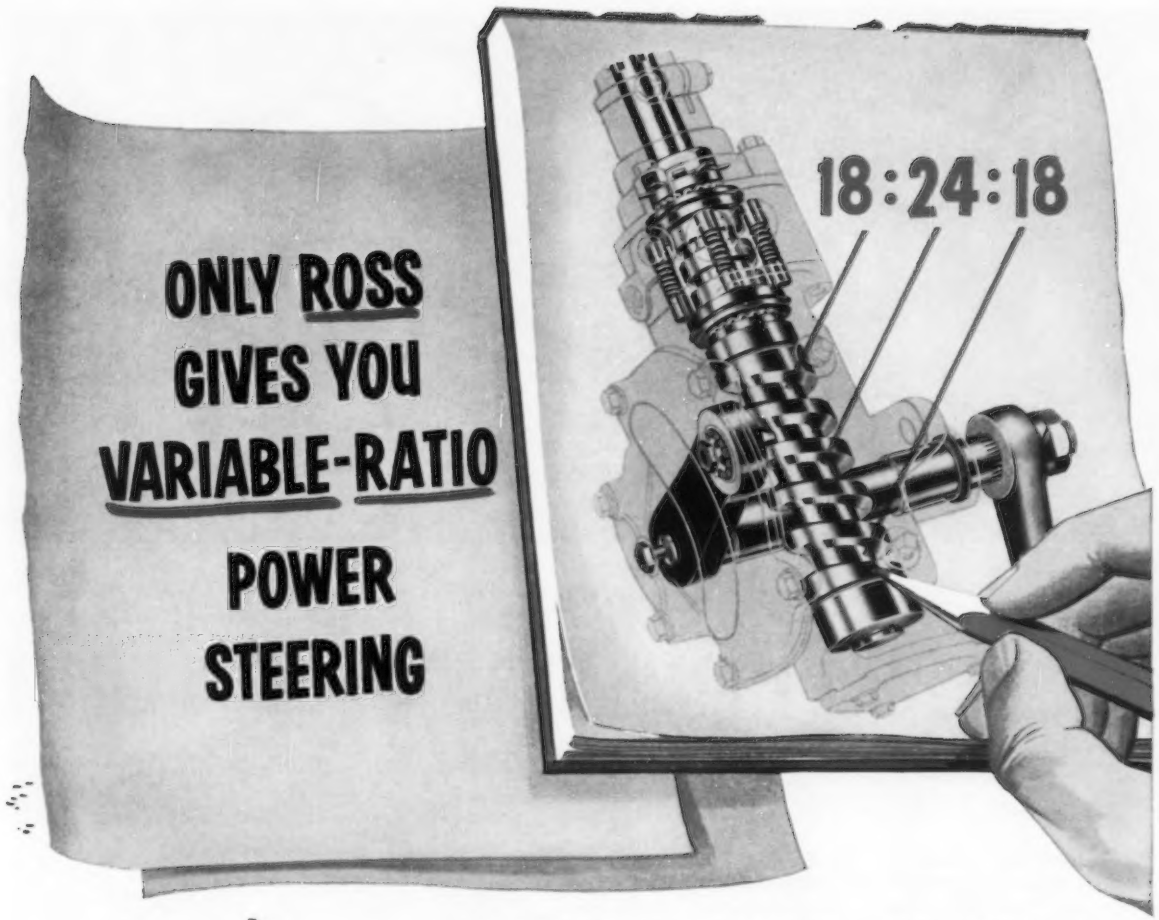

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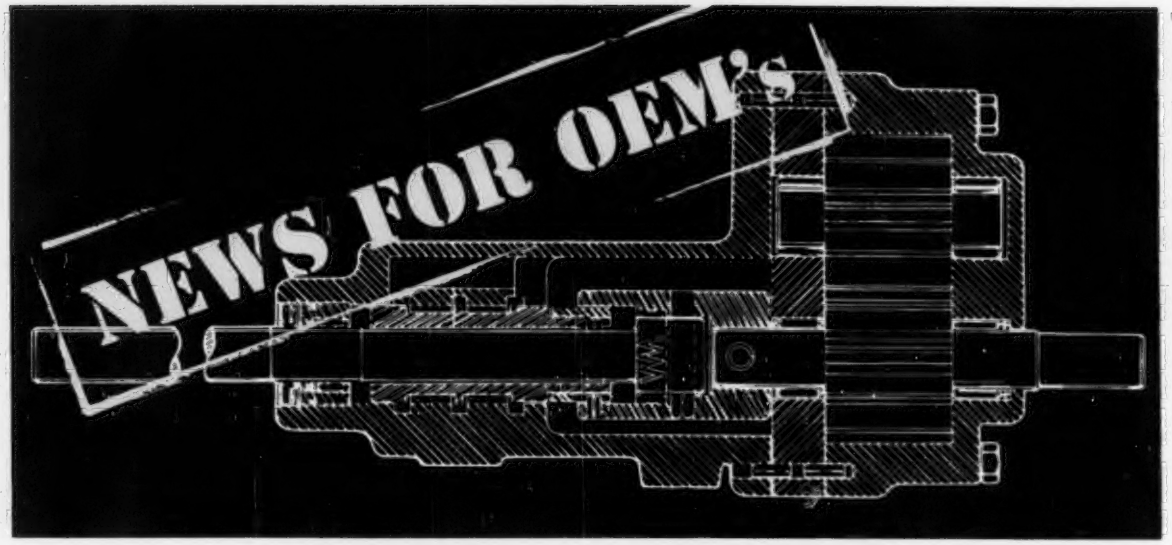

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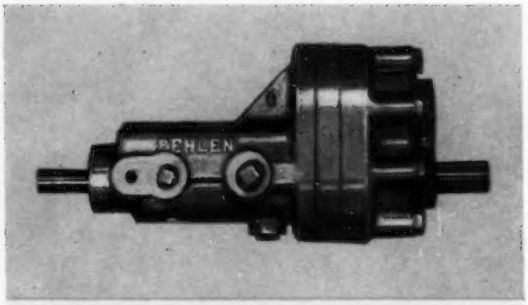

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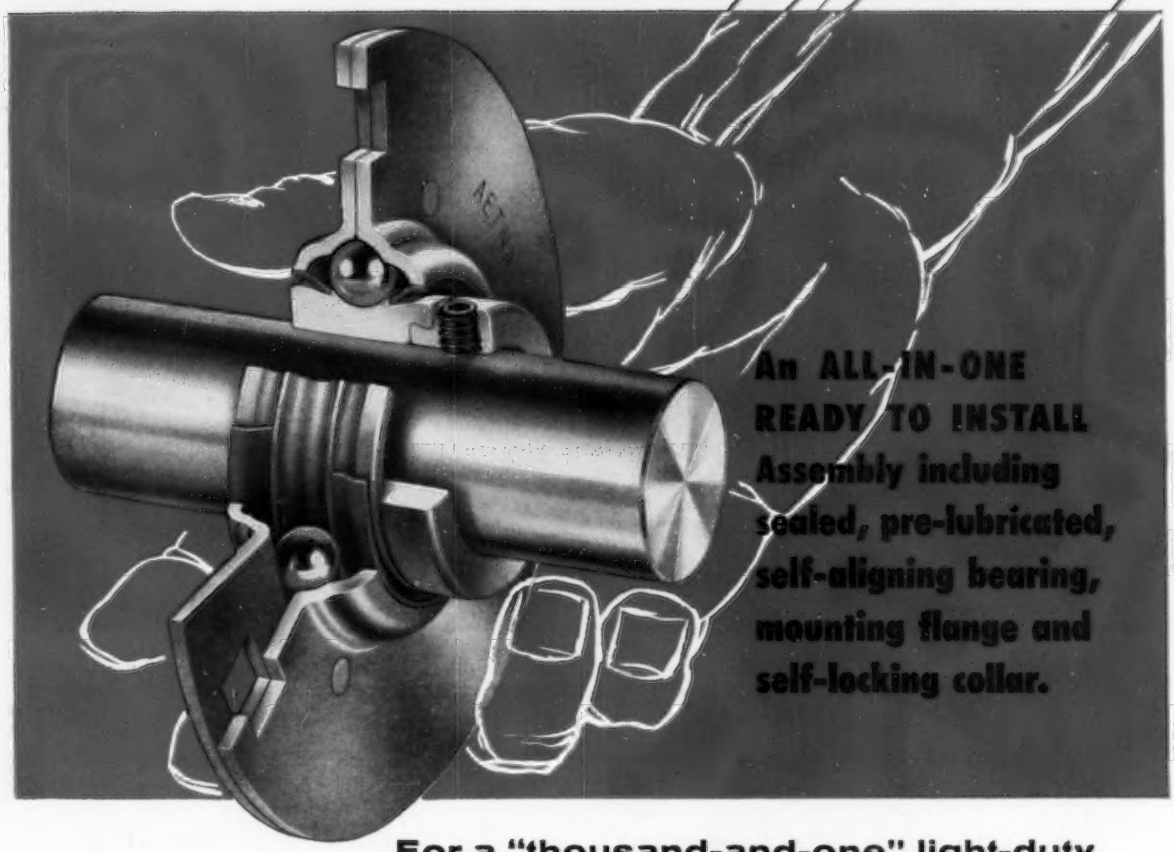

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Agricultural Engineering

May, 1958
Number 5
Volume 39

James Basselman, *Editor*

Farm Materials Handling Conference

THIS is the time of year when excitement and interest connected with the ASAE Annual Meeting are high. This year, especially, many of our members (and wives) are looking forward to a trip to the West Coast and California for the meeting to be held at the University of California, Santa Barbara Campus, June 22 to 26. The various program committees have done an excellent job in scheduling both interesting and informative papers, and the Pacific Coast Section has, from all advance information, gone all out to make this a most enjoyable and memorable meeting. A preview of the program appears on page 296 of this issue.

In previous years at this time, plans for other ASAE meetings could be shelved until after June. This normally would allow sufficient time for making arrangements for the fall Section meetings and the Winter Meeting in December. However, this year a special ASAE-sponsored Farm Materials Handling Conference will be held at Iowa State College, Ames, on September 17 and 18, and those who plan to attend, exhibit equipment or otherwise participate will need to make arrangements soon.

The Committee for Conference on Materials Handling, with S. S. DeForest as chairman, has arranged an outstanding program for the first national materials handling conference devoted specifically to agricultural materials. The program subcommittee, headed by W. M. Carleton, has lined up top-notch speakers and the subcommittee on local arrangements, headed by N. H. Curry, has made arrangements for crops to be grown at the site for actual crop-handling demonstrations.

The sessions are planned to be of interest to agricultural engineers, power suppliers, farmers and manufacturers and dealers in buildings and equipment for storing, processing and handling agricultural materials. Speakers will discuss all materials farmers handle including hay, silage, grain, ground feed, water, manure, products farmers buy, and products farmers sell. The objectives of the conference are to stimulate and encourage basic, cooperative progress among colleges, industries, power companies, and others in the development of materials handling methods for farms; to provide a reference for agricultural engineers, manufacturers, dealers, and farmers on the subject; and to establish ASAE and the agricultural engineering profession as an authoritative source for farm materials handling information.

The September issue of AGRICULTURAL ENGINEERING will carry all of the papers presented during this conference, as well as other materials handling features. By reason of the scope of the material it will contain, this special issue promises to be a comprehensive handbook on farm materials handling. Following is a preview of the program.

G. H. Seferovich, Editor, *Implement and Tractor*, will open the Wednesday morning session with a review of development and a forecast of future possibilities in mechanization of farm materials handling. C. W. Hall, Michigan State University, will follow with a discussion of the theoretical considerations in materials-handling systems. On Wednesday afternoon the theme will be principles of farm materials-handling. W. W. Gunkel, Cornell University; H. J. Barre, Mansfield, Ohio, and M. E. Singley, Rutgers University, will discuss liquid materials, free-flowing materials, and non-free-flowing materials, respectively. The evening program will include a presentation of lantern slides and motion pictures to illustrate techniques of handling agricultural products.

The theme for Thursday morning will be application of mechanical handling principles to representative products. Papers on liquid materials will be presented by J. F. Schrunk, Irrigation Equipment Co., who will give the discussion on water; W. E. Shiffermiller, the Borden Co., who will speak on milk, and C. M. Hansen, Michigan State University, who will discuss liquid fertilizer, liquid manure, liquid feeds, sprays, fungicides, herbicides, etc. A paper on free-flowing materials will be given by W. F. Miller. The discussion on non-free-flowing materials will be given by E. C. Schneider, University of Vermont who will speak on hay and manure; J. H. Ebbinghaus, A. O. Smith Corp., on silage; and H. B. Puckett, Farm Electrification Research Laboratory, who will discuss supplements, ground feed, fertilizer, ear corn, etc. J. H. Levin, (AERD, ARS), USDA, will give a paper on bales, sacks and pallets; C. L. Martin, The Farmhand Co., will present a discussion on loads, stacks, etc., and M. L. Todd of Todd, Hedeen & Associates, will discuss engineering analysis of an actual materials-handling installation. These three papers will be relative to the subject of unit (batch) materials. The evening session will consist of an analysis of what the mechanization of farm materials-handling portends for farming as a business, to be given by Kirk Fox, editor emeritus, *Successful Farming*, in a paper "The Job Ahead for Farm Materials-Handling."

On Friday there will be exhibits and field demonstrations of typical farm materials-handling equipment and systems as part of the annual Agricultural Engineering Field Day sponsored by the agricultural engineering department of Iowa State College. Displays, exhibits and demonstrations will be set up so that agricultural materials handling can be demonstrated from "field to storage, through processing, to livestock, to market." Information on display space may be obtained by writing to N. H. Curry, Agricultural Engineering Dept., Iowa State College, Ames. Copies of the program will be available soon and will be obtained by writing to ASAE, 420 Main St., St. Joseph, Mich.

ASAE 51st Annual Meeting • Santa Barbara Campus, University of California, June 22-25

Fundamentals of Pressure Distribution and Soil Compaction Under Tractor Tires

Concerned with necessity of German farmers to maintain or increase crop production following increased mechanization after World War II, much emphasis has been placed on avoiding practices not conducive to improved yields. Following is a study of the soil mechanics involved in soil compaction determinations made in Germany.

Walter Soehne

SOIL compaction is a problem of agricultural soil mechanics which deals with the effect of machinery on arable soil. It can be divided into the following partial problems:

1 Determination by measurement and calculation of the pressure distribution in the soil as a function of wheel load, tire inflation pressure, and soil conditions.

2 Determination of the principles of soil compaction or of the reduction of porosity of different soils in relation to the pressure at various moisture contents.

3 What conclusions can be reached concerning compaction and plastic flow under tires, if the pressure distribution in the soil under tires and the relation between pressure and compaction are known?

4 Investigation of the reactions when transmitting tractive effort from the tire to the soil and the deformation and shearing of the soil connected therewith, and also of the compaction and smearing caused by slip.

The designer, therefore, must select the tire size to fit the weight of the tractor in such a way that not only soil compaction is avoided as far as possible, but also high tractive forces can be transferred to the soil with low rolling resistance and little slip, resulting in good over-all wheel efficiency.

For the farmer and the agronomist the following questions arise:

In what way does soil compaction affect plant growth? What is the critical density in different soils that will cause a decrease in plant growth? Which plants are extremely sensitive to soil compaction?

Pressure Distribution in the Soil under Tires

A pressure stress-field under a tractor, trailer, or implement tire depends on the amount of load, the size of contact area between the tire and soil, and the distribution of surface pressure within this contact area as well as on the nature of the soil, its moisture content and density. The pressure distribution in the soil can be determined with sufficient accuracy by measuring and by calculating with semi-empirical formulas derived by O. K. Froehlich(1)*. The theoretical work on distribution of pressure in the soil is based on the studies of Boussinesq. They are valid only for an isotropic mass which follows Hooke's law.

If a force, Q, is applied at one point on the surface of a semi-infinite solid mass, then the vertical compressive stress in any volume element, having the polar coordinates r and θ, is found by the following formula:

$$\sigma_z = (3Q/2\pi\, r^2)\, \cos^3\theta \quad \text{(Fig. 1}a\text{)}$$

In Fig. 1b a volume element is shown with the polar principal stress

$$\sigma_r = (3Q/2\pi\, r^2)\, \cos\theta$$

As a result of numerous pressure measurements performed during investigations of soil mechanics by civil engineers, it was noted that there is a deviation in pressure distribution in the soil from the pressure distribution in a homogeneous isotropic mass. The pressure distribution within a mass which follows Hooke's law can be found by an exact calculation.

The compressive stress in the soil has a tendency to concentrate around the load axis. This tendency becomes greater when soil becomes more plastic due to increased moisture content and when the soil is less cohesive, for instance sand.

*Numbers in parentheses refer to the appended references.

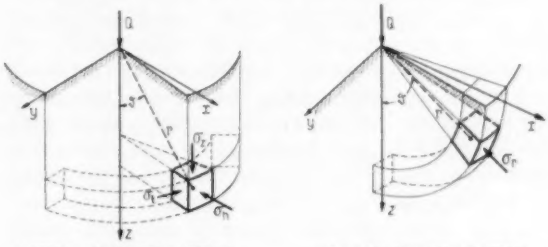

Fig. 1 Stresses in a volume element by a point load in a semi-infinite solid

Paper presented at the Golden Anniversary Meeting of the American Society of Agricultural Engineers, East Lansing, Mich., June, 1957, on a program arranged by the Power and Machinery Division.

The author—DR.-ING WALTER H. SOEHNE—is senior scientist at the department for basic research in agricultural engineering, Agricultural Research Center, Braunschweig-Voelkenrode, Germany.

Acknowledgment: The author wishes to thank A. W. Cooper, director, Tillage Machinery Laboratory Section, Auburn, Ala. for presenting the paper at the ASAE Golden Anniversary Meeting. Thanks also to J. K. Jensen, John Deere Research and Engineering Center, Waterloo, Iowa, who revised and prepared preprints.

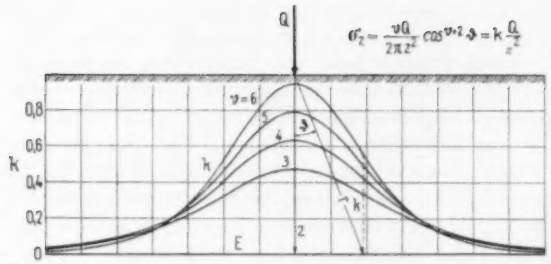

Fig. 2 Vertical pressure stress σ_z at different concentration factors

Froehlich has considered this by introducing a concentration factor to Boussinesq's formulas referring to a homogeneous, isotropic mass. Fig. 2 shows the perpendicular stress σ_z at the concentration factors $\nu=3$ to 6 under a single load Q at the depth z. The lower curve $\nu=3$ shows the distribution in an elastic isotropic mass according to Boussinesq. The curves $\nu=4$ to 6 represent distributions as they appear in soil. A suitable concentration factor has to be selected from experience and with the help of measurements. It is then possible to calculate pressure distribution in soils with different moisture content, cohesion and density. For the perpendicular stress

$$\sigma_z = (\nu Q/2\pi z^2) \cos^{\nu+2}\theta = k(Q/z^2).$$

The more the stresses concentrate around the axis of the load, the larger the factor of concentration must be. The reasons for this concentration are:

1 In the contact area there are introverted shearing stresses which cause an increase in perpendicular stress near the axis of load. These shearing stresses are relatively high in the contact area between the tire and the soil and are caused by the shrinkage of the rubber.

2 The modulus of elasticity, E, is not constant but generally increases with depth. On arable soil, mostly at the plow sole, there is a step to a higher density and to a higher modulus of elasticity which also causes introverted shearing stresses.

3 The deformation of the soil is not only elastic, but, to an even greater extent, is plastic. This causes the soil to yield at the edge of the load area, which also leads to a concentration of pressure under the axis of load.

These three reasons for stress concentration depend more or less on the kind and moisture content of the soil.

To get an idea of the stresses under a single load, Q, the lines of equal polar principal stresses σ_r are determined. The polar principal stress is more important for the compaction of the soil than the perpendicular stress σ_z. At the load axis $\sigma_r = \sigma_z$. With increasing distance from the axis, σ_r becomes larger than σ_z.

$$\sigma_z = \sigma_r \cos^2\theta$$

Curves of equal principal stresses form circles for the concentration factor $\nu=4$ and increasingly elliptic curves for $\nu=5$ and 6 (Fig. 3).

A tire transfers its load to the soil not (not even approximately) at one point, but contacts a finite area of soil. Therefore, it is necessary to replace Q in the Froehlich formulas by the integral $\int p\,dA$. This means to integrate the pressure, p, over the contact area between the tire and the soil. This integration is possible only under the load axis unless undue mathematical effort is exerted. Therefore, it may be easier to divide the contact areas into a sufficient number of partial areas in whose centers of gravity the corresponding single loads act. The whole field of pressure stresses will be obtained by superposition of the stresses from single loads. As the pressure stresses are tensors, the superposition of perpendicular stresses σ_z is a simple addition. The superposition of the principal stresses σ_1 follows a more complicated law(2).

The next problem is to determine the size of the contact area between the tire and the soil and the pressure distribution existing in this area. Fig. 4 shows measured areas of contact between tires and soil under different soil conditions. The tire track on any soil will become deeper with increasing porosity and moisture content. The deeper the tire track, the larger the contact area. The average surface pressure decreases accordingly.

An approximately equal pressure over the entire contact area can be assumed when large-volume tires without lugs are in contact with hard dry soil. This is not true for plastic and soft soils. In the contact area, the pressure depends upon the specific depth of the track. If there is plastic flow to the side of the contact area on a moist soil and soil compaction under the tire, then the pressure decreases toward the outside of the contact area and the pressure is more concentrated towards the center of the load. Examples of resulting pressure distributions are shown in Fig. 5.

For a dense, hard, dry, cohesive soil which is only elastically deformable, a pressure distribution over the contact area can be assumed according to case one. This pressure

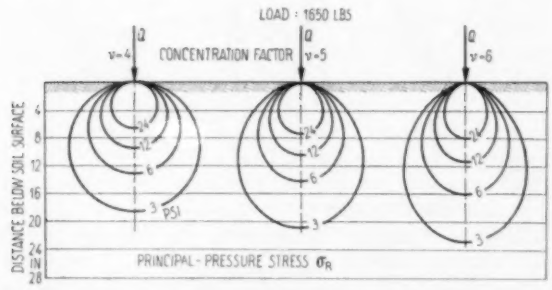

Fig. 3 Curves of equal pressure (pressure bulbs) under a point load at different concentration factors

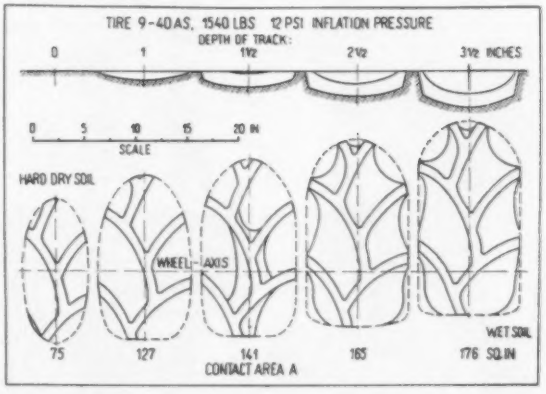

Fig. 4 Contact areas between tire and soil for different soil conditions

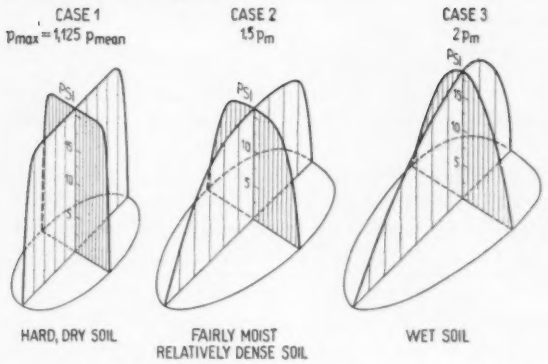

Fig. 5 Examples of the pressure distribution in the contact area between tire and soil

distribution was developed from a load on a circle area according to the formula

$$p=p_{max}\ [1-(\rho^{16}/R^{16})]$$

where R=the radius of the circle area

ρ=the respective distance of the relation point from the center of the circle area

In this case $p_{max}=1.125\ p_{mean}$. For a sandy clay soil, fairly moist, relatively dense (case 2), we may assume a distribution following a parabola of the fourth degree,

$$p=p_{max}\ [1-(\rho^4/R^4)] \text{ then } p_{max}=1.5\ p_{mean}$$

For a plastic flowing wet soil, (case 3), we have a distribution which may be shown by a quadratic parabola

$$p=p_{max}[1-(\rho^2/R^2)].$$

In this case the maximum pressure, p_{max}, is equal to twice the average unit pressure in the contact area.

$$p_{max}=2\ p_{mean}$$

The integral of the pressure in the contact area is, of course, equal in all three cases.

Tractor tires, however, have a tread pattern with rather high lugs. Therefore, the pressure distribution on the soil surface changes in the following way: On a hard dry soil the lugs of the tire carry the whole load. The pressure in the contact area of the lugs is three to four times higher than in a contact area without lugs as shown in Fig. 5. But in a depth of 3 to 4 in. already the pressure is distributed over the whole elliptical load area. Besides that, the hard, dry soil is so insensitive to compaction that the higher pressures under the lugs do not compact the soil essentially. On more soft soil with a middle track depth the load is distributed already on the lugs and the grooves (or slots) of the tire profile. In this case the pressure may be one and one-half to two times as high as under a tire without lugs. On a rather wet soil, which is really sensitive to compaction, the soil deforms plastically so much that it can be assumed that there is hardly a difference between the pressure under lugs and under the grooves of the profile.

Fig. 6 shows pressure distributions in the soil under different wheel loads. These were calculated for case 2 in Fig. 5, in which a soil having normal field density and moisture was assumed. The factor of concentration was assumed to be $\nu=5$. The wheel load was varied from 660 to 2200 lb. The tire dimensions were chosen according to the load and, since the tire inflation pressures are equal, similar pressure distributions in the contact areas are assumed. The contact areas are proportional to the wheel load. The maximum and mean surface pressures were assumed to be the same in all cases, and furthermore the pressure distribution was assumed to follow a parabola of fourth degree.

The bulb-shaped pressure curves have the same principal stress, σ_1, which is more pertinent to compaction than the perpendicular stress, σ_z. Fig. 6 shows how much deeper the bulb-shaped pressure curves reach under the surface for greater wheel loads, although the surface pressure is the same. For example, the 6-psi pressure curve for the 13-30 tire under a 2200-lb load, reaches about 43 percent deeper than does the same pressure curve for the 9-24 tire with a 1100-lb load.

Fig. 7 shows how the strength of the soil is reflected in the shape of the pressure curves. With hard, dry, and dense soil (case 1), the lines of equal principal stress are approximately circular. The softer the soil, when comparing case 1 with cases 2 and 3, the narrower the pressure curves become. The reason is, as already mentioned, that on soft soil the soil can flow aside so that the pressure distribution is concentrated toward the load axis.

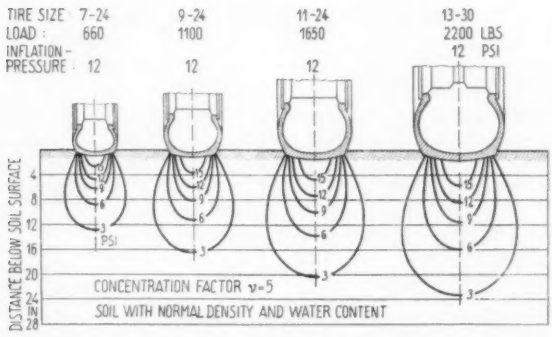
TIRE SIZE 7-24 9-24 11-24 13-30
LOAD : 660 1100 1650 2200 LBS
INFLATION-PRESSURE : 12 12 12 12 PSI
DISTANCE BELOW SOIL SURFACE
IN
PSI
CONCENTRATION FACTOR ν=5
SOIL WITH NORMAL DENSITY AND WATER CONTENT

Fig. 6 Calculated curves of equal pressure (pressure bulbs) under different tractor tires

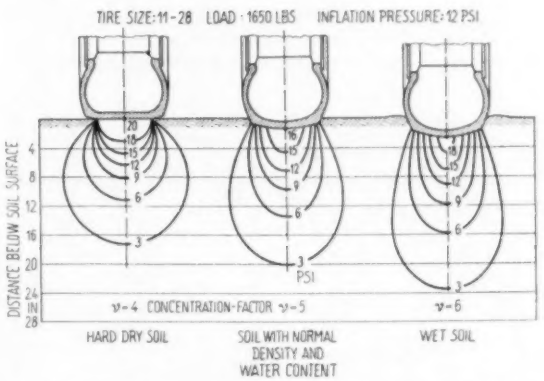

Fig. 7 Calculated curves of equal pressure (pressure bulbs) under a tractor tire for different soil conditions

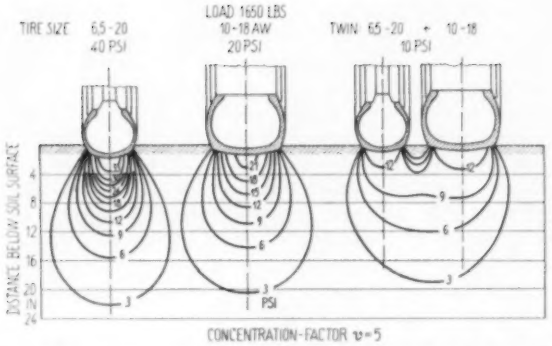

Fig. 8 Calculated curves of equal pressure (pressure bulbs) under narrow, wide and twin trailer tires with different inflation pressures

Finally Fig. 8 shows the pressure distribution under the same wheel load but with different tire dimensions and inflation pressures. Note that the maximum pressure of 33 psi under the narrow 6,5-20 tire which leaves a deep track is smaller than the inflation pressure of 40 psi. The maximum pressure under the twin tires of 12 psi is greater than the inflation pressure of 10 psi.

The figures shown will give only an impression of how we must visualize the pressure fields, that is, the pressure distributions in the soil. The figures show the relation between the wheel load, tire dimensions, tire-inflation pressure and different soil conditions; they do not give exact values in all cases. This is impossible due to the heterogeneity of the soil.

The Principles of Soil Compaction

With different moisture content and different nature and condition of the soil, almost equal stresses can cause completely different soil deformations. It is necessary to distinguish the following kinds of soil deformation as a result of external forces:

(a) Elastic soil deformation

(b) Soil compaction

(c) Soil deformation by plastic flow.

Distinguishing these deformations is rather complicated because these three kinds of deformation always coincide and are superimposed.

Soil compaction is the most important kind of deformation. It is the reduction of pore space and the increase of apparent specific weight by an external compression. The force of gravity, rain, or chemical influences also cause soil compaction. In the following, only soil compaction by external pressure, that is, by mechanical forces, will be discussed. To determine the relation between soil compaction and pressure, we have used, in general, two methods, namely, static and kneading soil compaction.

For the static compression tests, cylinders with an outside diameter of 11.2 in., 6.2 in. high, were used. The cylinder was filled either with undisturbed soil samples taken from the field or with loose soil. Then the soil was compressed slowly by a hydraulic press. From the weight of the soil sample in the cylinder, the relation between porosity and pressure was found by measuring its water content and volume during the compression test.

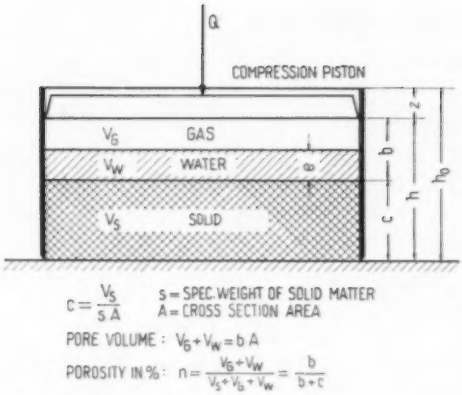
Q
COMPRESSION PISTON
V_G GAS
V_W WATER
V_S SOLID
z
b
h
c
h_o
$c = \frac{V_S}{s\,A}$ s = SPEC. WEIGHT OF SOLID MATTER A = CROSS SECTION AREA
PORE VOLUME : $V_G + V_W = b\,A$
POROSITY IN % : $n = \frac{V_G + V_W}{V_S + V_G + V_W} = \frac{b}{b+c}$

Fig. 9 Volume of solid matter and water and gas pore volume in a compaction cylinder

Fig. 9 shows the compaction cylinder with diagrammatic representation of volumes. The total volume, V, of the soil sample consists of the volume of solid matter V_s and the pore volume. This pore volume is subdivided into water volume V_w and gas volume V_g. The volume of solid matter equals the dry soil weight divided by the specific weight of the solid matter. The height, c, is the equal to the dry soil weight divided by the specific weight of solid matter in the cylinder and the cross section area, A. z is the displacement of the compression plunger from its original position b. b is equal to $b_o - z - c$. The porosity is then $n = b/(c+b)$.

There is no plastic flow of soil in the compression cylinder described above, since during the static-compression test the plunger covers the entire cylinder cross section.

This is the main difference between static soil compression and that which occurs under farm rubber tires. In order to approximate more closely the actual condition under rubber-tired wheels, a simple kneading compactor was developed (Fig. 10). The soil is compacted in a cylinder by a ram or plunger. The ram fills only a quarter sector of the cylinder cross section, so that soil can flow to the side of the ram. Cylinder diameter is 4 in. There is a spring between the hand-operated lever and the ram which measures the

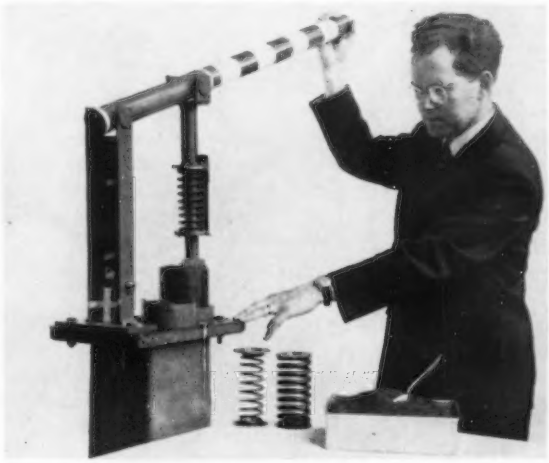

Fig. 10 Kneading compactor

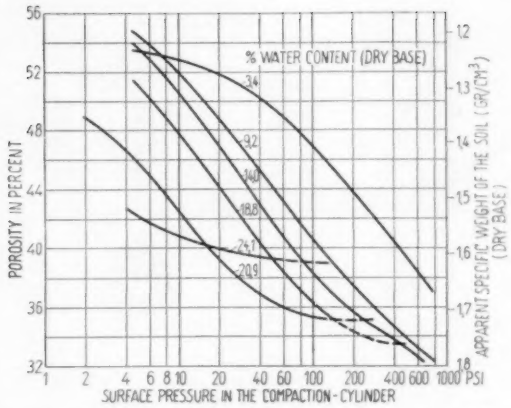
% WATER CONTENT (DRY BASE)
34
32
24.1
20.9
18.8
POROSITY IN PERCENT
APPARENT SPECIFIC WEIGHT OF THE SOIL (GR/CM³) (DRY BASE)
SURFACE PRESSURE IN THE COMPACTION-CYLINDER
1 2 4 6 8 10 20 40 60 100 200 400 600 1000 PSI

Fig. 11 Compaction curves of a loose loamy clay soil at different water contents

kneading force. By interchanging springs, different forces can be applied. As soon as the applied force has reached a preset value, an electric bulb lights up. Springs are sized so that surface pressure can be varied from 7 to 210 psi. The pressure is always doubled in six steps. After every compression by the ram, the cylinder is turned 90 deg and in this way the whole soil surface is compressed. As with the Proctor compactor (using dropping weight), the soil is introduced to the kneading compactor in three layers which are compressed one after the other. Then the soil weight and moisture content are measured and the porosity is calculated in the same way as after the static compaction test.

Fig. 11 shows the results of a compaction test of a heavy, loamy soil in relation to the pressure at different moisture contents. The ordinate on the left side of the diagram gives the porosity and on the right side the apparent specific weight of the soil. The abscissa is the surface pressure on a logarithmic scale. The compaction or the reduction of porosity in relation to the pressure follows a logarithmic law. Therefore, it is more convenient to use a logarithmic than a linear scale for the pressure.

The single compaction curves are valid for given moisture contents of the soil. The higher the moisture content of the soil, the more it is compacted by the same pressure. But this happens only to a certain moisture content—the so-called optimum water content—at which the density of soil reaches the maximum for the given compaction effort. The curves representing the higher moisture contents of 24.1 and 20.9 percent become horizontal at the high pressure side. This indicates that all pores are filled with water and that the soil cannot be compacted any more by short, temporary loads. The influence of the moisture content is extremely high on this heavy loamy clay soil. For example, to compact this soil when dry (3.4 percent moisture content) to 42 percent porosity, it is necessary to have a surface pressure of 285 psi. To achieve the same results when the soil has 14 percent moisture content requires 48 psi, while the soil in a wet condition needs only approximately 5.6 psi. This means that in order to obtain the same compaction for this wet soil, it is necessary to have only 1/9 of the pressure which is required for average normal moisture content and only 1/50 of the pressure on air-dried soil.

This result may be shown in another diagram (Fig. 12). The porosity and the apparent specific weight are shown on the ordinate, the moisture content on the abscissa. The curves show the porosity which results at 5, 10, 20, 40, 80, and 160 psi. Comparing air-dried soil with soil of 10 percent moisture content, one can see that the porosity is considerably decreased. Within the limits of 10 to 19 percent moisture content, which is the normal moisture content in the field, the curves drop slowly. In case the water content increases to more than 19 percent, the porosity drops abruptly. It shows that this soil is very sensitive to compaction at moisture contents greater than 19 percent. The shaded part of the figure shows the water-filled part of the pore volume at higher water contents. The soil can be compacted only to this limit by pressures of short duration. If the soil is subjected to that pressure for a longer period of time, water will be squeezed out of the soil. If the soil has a water content of 22 percent, it can be compacted only to a porosity of 37 percent.

Fig. 13 shows the results of a kneading compaction test compared with a static compaction for a loess soil, *i.e.*, a wind-blown soil. The curves obtained by the kneading compaction show steeper slopes than the curves from the static-compaction tests. In order to reproduce the relationship be-

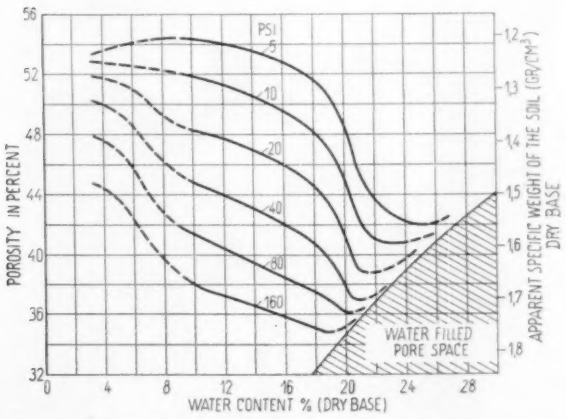

Fig. 12 Compressibility of a loamy clay soil by different pressures in relation to the water content

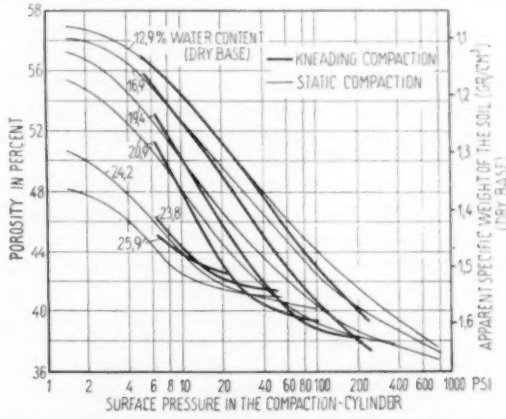

Fig. 13 Compaction curves of a loose loess soil by static and kneading compaction at different water contents

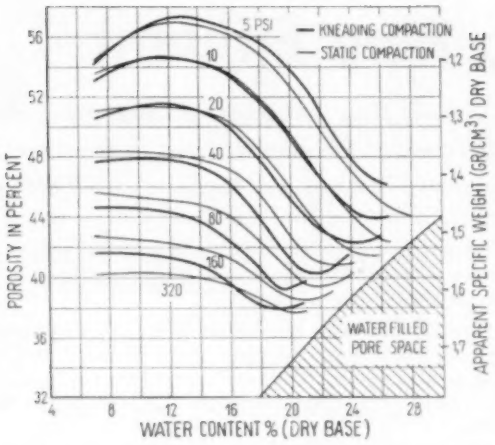

Fig. 14 Compressibility of a loess soil by static and kneading compression in relation to the water content

tween porosity and pressure in the soil, the following formula is used in civil engineering soil mechanics:

$$\epsilon = -A \ln p + C.$$

Accordingly, the void ratio ϵ, the ratio between the pore space and the volume of solid matter, changes with the natural logarithm of the applied pressure. In consequence of the author's tests it seems that for arable soils, compaction tends to follow the formulas:

$$n = -A \ln p + C$$

or

$$n = -A^* \log p + C$$

There is a logarithmic relation between porosity n, and pressure. C is the porosity which is obtained by compacting loose soil at a pressure of 10 psi.

$$A^* = -d\,n/d \log p$$

Accordingly, A^* gives directly the decrease of the porosity if pressure increases from 10 to 100 psi. Static tests performed by us gave values of approximately 10 for soils such as sand, fine sandy loam, and loess. For loamy clay the value of A^* was found to be 12, for another loam, 14. For another clay with a high degree of limestone, the surprisingly high value for A^* of 20 was measured. This means that, if the pressure increases by a factor of ten, for example, from 10 up to 100 psi, or from 50 up to 500 psi, the porosity of loess decreases about 10 percent. If the pressure increases twofold, the porosity decreases about 3 percent. The value of A^* for the same loess, determined by the kneading compaction test, is equal to about 14.

This difference between static compaction and kneading compaction is perhaps more evident in the Fig. 14. At relatively small pressures the curves of static compression and kneading compaction show only small differences. However, the difference between static and kneading compaction becomes greater at higher pressures. With a pressure of 160 psi and 20 percent water content, kneading compaction results in greater reduction of porosity than that obtained by static compaction at 320 psi. On loamy sand soil the difference between static and kneading compaction was the same as on the loess soil. The difference was not as evident on a heavy loam. The value of A^* was equal to 14 in both cases.

A^* is the slope of the curve on a logarithmic scale.

Plastic Flow of the Soil

Besides the soil compaction, it is necessary to investigate the plastic flow of soil under tires. Deep tracks on dense, wet soils may be caused more by plastic flow than by soil compaction. These deep tracks are as disadvantageous as soil compaction. If the soil has greater plastic deformation, the rolling resistance of tractor and implement tires is higher and the drawbar pull of tractors is lower.

At the same time slippage increases. Deep wheel tracks may tear plant roots and the tracks will hinder subsequent field work. Plastic flow occurs if the shear stresses in the soil exceed yield strength. This strength depends on the moisture content of the soil to a greater degree than does the compressibility. Plastic flow is influenced by the size of the load area, *i.e.*, by the tire dimensions and the inflation pressure.

To determine the forces necessary for plastic soil deformation at different moisture contents the following test was made. A sample of relatively dense fine sandy loam was placed in a cylinder with a diameter of 11.2 in. Then a plunger 6.5 in. in diameter was applied concentrically to the sample. The forces to produce equal soil deformations at different moisture contents were measured as follows:

Moisture content, percent	10	16	20	22	26
Pressure relation	11.8	5.3	2	1	1/7

With respect to the track depth, a tractor may still travel over this soil when it has a moisture content of 22 percent. At a mean moisture content of 16 percent, the pressure may be 5.3 times as high, but for wet soil with 26 percent moisture content the pressure may be only one-seventh as much for equal track depths.

Even though the pressure relations are influenced by the dimensions of the cylinder and plunger and by friction on the cylinder wall, they show roughly the magnitude of the relation between plastic flow and moisture content. It is impossible for the designer of tires and tractors to reduce the pressure to such a degree that a tractor can travel over a wet soil without making deep tracks.

In addition to soil compaction caused by pressure, soil smearing and compaction may be produced by slippage of the tire. This is also detrimental to plant growth. However, slippage compacts or smears only a rather thin soil layer. Deep compaction of the soil such as that caused by the pressure distribution under loaded tires will not occur. Therefore, it may be easier to remove surface compaction caused by slippage by means of track eradicators.

The following demands are made on the designers of tractors and tires:

1 The weight of tractors and machinery should be further reduced. If weight is necessary for traction, the tractor should be weighted by detachable weights and water filling of the tires.

2 Wider tires with a lower inflation pressure should be provided in addition to the rather narrow standard equipment tires which are necessary in Germany to cultivate pota-

(Continued on page 290)

Device for Measuring Pipe Effluent

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While testing various flow measuring devices the authors uncovered important information that led to the development of an improved method for measuring pipe effluent

A STUDY of drainage by pumping was begun at the Minnesota Agricultural Experiment Station in the summer of 1955. Early efforts were concerned with basic relations for the design of pump drainage systems (1)*. Another part of the project is a study of flow rates from tile drainage systems, including maximum rates, fluctuations, and annual amounts.

To obtain such data, a measuring device capable of obtaining a continuous record of a wide range of flows is needed. A study of a tile-effluent measuring device, utilizing a pivoted float, was reported in 1949 by Donnan and Bradshaw(2). In order to study the suitability of devices of this type, the authors began a series of experiments which led to the development of the new device described in this article.

Description and Principle of Operation

The new device has been called a slotted-tube flow meter. It consists primarily of a slotted tube mounted vertically at or near the end of a pipe with the slot directed upstream. Arrangement of parts and important dimensions for use of the device in smooth-wall pipes of various diameters are shown in Fig. 1.

The water level in the slotted tube, measured from the bottom of the pipe, is used as an index of discharge. This *head* corresponds closely to the specific energy of the flow, *i.e.*, depth plus velocity head. For convenience, damping, and greater accuracy, the head is measured in a stilling well which is connected by a hose to the lower end of the tube. The head can be measured manually with a point or hook gage, or by means of a water stage recorder if a continuous record of the flow is needed.

Calibration Data

A theoretical calibration for the slotted-tube flow meter was obtained by assuming critical depth at the face of the slotted tube and no loss of energy. For an 8-in. pipe, the specific energy was calculated for various depths, and, in Fig. 2, is plotted against discharge in gpm. Also shown in Fig. 2 is the calibration curve obtained with the 8-in. pipe. Although the calculated curve is similar to the actual rating, the two curves do not agree throughout. Most likely this is because the location of critical depth varies with discharge. As shown in Fig. 2, the general shape of the calibration curve is such that low flow rates as well as high flows can be measured with good accuracy.

Rating data for the slotted-tube in 6 and 8-in. aluminum pipes at 0.25 percent slope are presented in the first two columns of Table 1. Maximum capacity for each pipe size was taken as the point where the test pipe began flowing full.

Since corrugated steel pipes frequently are used as tile outlets, a series of tests was made with the slotted tube attached to the end of a 10-in. corrugated pipe as shown in Fig. 3. As before, the tube diameter was made equal to one-eighth of the pipe diameter, but the pipe slope was changed to 0.50 percent. The resulting calibration data are given in Table 1.

TABLE 1. RATING TABLE FOR SLOTTED-TUBE FLOW METER IN 6 OR 8-IN. SMOOTH-WALL PIPE AT 0.25 PERCENT SLOPE AND IN 10-IN. CORRUGATED STEEL PIPE AT 0.50 PERCENT SLOPE.

Gage height (feet)	Discharge in gallons per minute for: 6-in. pipe (I.d. = 5.874 in.)	8-in. pipe (I.d. = 7.812 in.)	10-in. pipe (I.d. = 10.0 in.)
0	0	0	0
0.05	1.6	2.0	4
0.10	7.4	8.0	13
0.15	18.4	20.5	28
0.20	36.0	40.0	50
0.25	57.2	65.0	80
0.30	81.4	94.5	117
0.35	109.2	127.5	162
0.40	138	166	212
0.45	165	208	271
0.50	192	252	332
0.55	219	298	400
0.60	——	346	470
0.65	——	393	540
0.70	——	437	615
0.75	——	480	690
0.80	——	——	765
0.85	——	——	835
0.90	——	——	910

The calibration data as given in Table 1 are, of course, applicable only to the exact inside diameters used in the tests. In the case of the smooth-wall pipes, ratings for other types of pipe with different inside diameters may be necessary. To meet this need, the ratings for the 6 and 8-in. pipes were reduced to a form independent of pipe diameter. Values of H and Q for the two pipe sizes were converted to the ratios H/D and $Q/D^{5/2}$, where H is the head in feet, D is the inside diameter in feet and Q is the discharge in cubic feet per second. In this form, the two ratings plotted as a single curve. Thus, the rating can be used for any diameter within the range of the tests, and probably for diameters considerably larger or smaller. Points from the

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*Numbers in parentheses refer to the appended references.

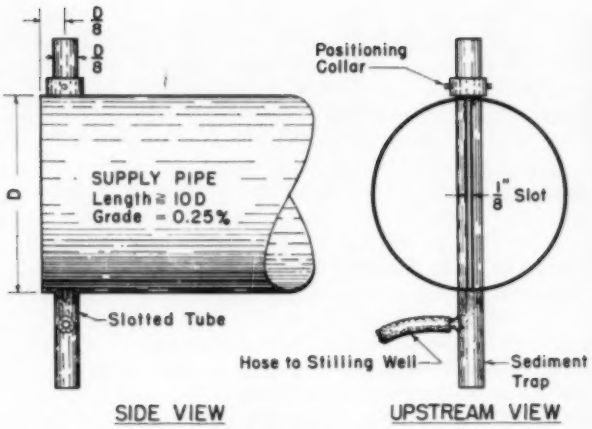


Fig. 1 Arrangement of parts and dimensions of slotted-tube flow meter for smooth-wall pipes

combined rating curve are given in Table 2. This table can be converted to an actual rating by multiplying values of H/D and $Q/D^{5/2}$ by D and $D^{5/2}$, respectively.

TABLE 2. RATING TABLE FOR SLOTTED-TUBE FLOW METER, IN SMOOTH-WALL PIPES, INDEPENDENT OF PIPE DIAMETER.

H/D	$Q/D^{5/2}$	H/D	$Q/D^{5/2}$
0	0.000	0.60	1.04
0.10	0.020	0.70	1.38
0.20	0.093	0.80	1.75
0.30	0.247	0.90	2.14
0.40	0.452	1.00	2.52
0.50	0.731	1.10	2.88

(H = head in feet, D = pipe diameter in feet, Q = flow in cu ft per sec)

Test Procedure

Exploratory tests were conducted using a 2-in. pipe as a model. The model tests indicated that the slotted tube would be a satisfactory measuring device, and served to establish the approximate capacity of the prototype. Full scale tests were then carried out to obtain calibration data and to determine the effects of factors which might influence the ratings.

Fig. 3 Slotted-tube flow meter as used in 10-in. corrugated pipe

In the full scale tests, average flow rates were determined by the use of weighing tanks. Gage heights were measured to 0.001 ft by means of a point gage and stilling well. For each test, observations were made with discharges from 1 to 100 percent of capacity.

Effects of Test Factors

Test variables included the tube diameter, tube location, pipe diameter, pipe slope, and pipe length. Altogether, 36 complete tests were made, in addition to the model tests.

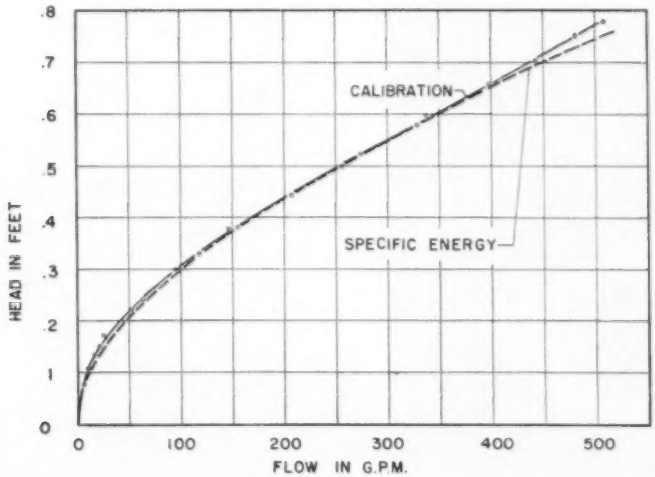


Fig. 2 Comparison of theoretical and experimental rating curves for 8-in. slotted-tube flow meter

Since the model tests indicated that a tube diameter equal to one-eighth of the pipe diameter was satisfactory, this approximate ratio was maintained for all subsequent tests. However, this exact ratio cannot always be obtained with standard tubing. One series of tests was made to determine the effect of minor variations in tube diameter. With the 8-in. aluminum pipe, tests were conducted both with a 1-in. hard copper tube, which had an outside diameter of 1⅛ in., and with a steel pipe machined to an outside diameter of 1 in. Since the two tubes gave identical results, hard copper tubing of standard size was used in the remainder of the tests.

The tube location for smooth-wall pipes, shown in Fig. 1, was chosen partly for convenience and also to be at or near the point of critical depth. No variation from this tube location was made with the smooth-wall pipes. In the tests with corrugated steel pipe, the tube was first placed further upstream, centering on a corrugation, then clamped on at the end of the pipe. Inasmuch as the latter arrangement proved satisfactory and more convenient, it was used for the remaining tests with corrugated pipe.

Various slopes were used on the test pipes to determine the most desirable slope for each type of pipe and to determine the effect, if any, of the pipe slope on the rating curves. With the 8-in. aluminum pipe, slopes of 0, 0.25, 0.5, and 1.0 percent were used in the tests. In each case an increase in slope caused a slight increase in head for a given discharge. Since the flatter slopes seemed to give more consistent results, a slope of 0.25 percent was selected as being the best for the smooth-wall pipes. In a similar series of tests with corrugated pipe a standard slope of 0.50 percent was selected. However, within the range of slopes used on the corrugated pipes, the ratings were not affected by the slope. Thus, the rating curve for the 10-in. corrugated pipe can be used for any pipe slope from 0.25 to 1.0 percent.

With the aluminum pipes at 0.25 percent grade, computations indicated that the flow was subcritical for low and moderate discharges, and supercritical for high discharges. With the corrugated pipes at 0.50 percent grade, the flow was subcritical throughout the range of discharges used. No doubt this is the reason why the ratings of the slotted-tube meter were affected by slope in the case of aluminum pipe, but not in the case of corrugated pipe. It would be possible to reduce the slope of the smooth-wall pipe still further in order to maintain subcritical flow in the pipe, but this would reduce its capacity and have other disadvantages.

Various lengths of pipe were tested to determine the minimum length of pipe that will give satisfactory results with the slotted-tube flow meter. Sections of 8-in. aluminum pipe 15, 10, 7½, and 5 ft long were used in the tests. For a given slope, all four tests plotted as a single curve. However, the test points for the shortest length did not follow the curve as well as the others. With the 10-in. pipe, lengths down to 8 ft (9.6 diameters) gave good results. On the basis of these tests, a figure of 10 diameters was selected as the minimum pipe length.

Other factors which might affect the ratings of the slotted-tube flow meter are slot width, pipe roughness, degree of submergence and approach conditions. These factors were not studied directly in the tests. However, since the slot width was not a factor in the theoretical rating previously referred to, it appears that the slot width does not affect the ratings. Furthermore, the variation in relative slot width between the 8 and 10-in. pipes did not have a noticeable affect. From field observations, it is evident that partial submergence does not influence the head readings. In all of the laboratory tests, the diameter of the test pipe was equal to or less than that of the approach pipe. Also, the slope of the test pipe was greater than the slope of the supply pipe. These approach conditions were maintained in order to avoid retarded flow conditions in the test pipes. In one test, a misalignment of 15 deg was used between the supply pipe and the test pipe, with no noticeable effect on the rating curve.

Application of the Slotted-Tube Flow Meter

The new device has been used two years on pump drainage experiments in Minnesota with good results. In each case, an assembly including a frame, test pipe, slotted tube, and 12-in. stilling well was suspended within the sump by means of steel wires and turnbuckles. For most of the in-

(Continued on page 287)

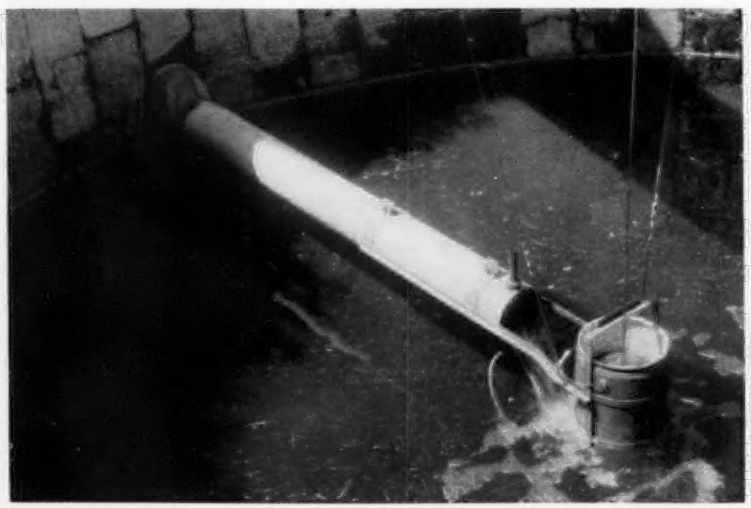


Fig. 4 Field installation of 8-in. slotted-tube flow meter in drainage sump

Analyzing Disk Cuts Graphically

J. L. Thompson
Member ASAE

J. G. Kemp
Assoc. Member ASAE

A graphical method has been used to illustrate the effect of disk diameter, spacing and angle of cut of a disk implement on the required depth of operation for a clean cut of weeds

IN THE design of one-way disk implements, the diameter, spacing, and angle of cut of the disks are factors which affect the operating characteristics of these implements. These factors also determine the depths of operations required to obtain a complete or clean cut of the ground surface and weeds. A graphical method has been developed which illustrates the relationship of these variables to depths of operations encountered in the field. Reference to the illustrations presented in this article should give a better understanding of the fundamentals involved in the operation of these implements, and thus clarify the adjustments required to obtain the desired results and to improve the quality of work obtained from disk equipment.

Paper prepared expressly for AGRICULTURAL ENGINEERING as a contribution from Experimental Farms Service, Canada Department of Agriculture, Ottawa.

The authors — J. L. THOMPSON and J. G. KEMP — are, respectively, officer-in-charge, agricultural engineering section, Dominion Experimental Farm, Swift Current, Sask., and agricultural engineer, Field Husbandry Division, Central Experimental Farm, Ottawa.

The methods as described by French (1)* and Giesecke (2) were used to develop the projections for the following conditions:

- 16-in. diameter disk with spacings of 6 and 7 in. at 30 and 45-deg angle of cut.
- 18-in. diameter disk with spacings of 6 and 7 in. at 30 and 45-deg angle of cut.
- 20-in. diameter disk with spacings of 7, 8, 9, and 10 in. at 30, 40, and 50-deg angle of cut.
- 24-in. diameter disk with spacings of 7, 8, 9, and 10 in. at 30, 40, and 50-deg angle of cut.

The projections for each of the above drawings include the depths 1, 2, 3, 4, and 5 in. The disk angle as stated by Gordon (3) is the angle between the plane of the disk edge and the direction of travel. This angle is referred to in the text as the angle of cut.

Discussion

No attempt will be made to cover each drawing in detail. A few examples have been chosen to illustrate the usefulness of the drawings. On referring to the figures it will be observed that the disks cut elliptical shaped furrows which leave ridges between the bottom of the furrows. The depth of operation of the disk implement required for a complete cut of the surface soil is controlled by the overlap of the cut of the disks. In order that the disks will completely cut all the weeds, it is essential that the disk implement be operated at least ½ in. deeper than required depth for a complete cut of the surface on smooth land. This depth will be referred to hereafter in the text as a clean cut.

*Numbers in parentheses refer to the appended references.

Fig. 1A 16-in. disk at 45-deg angle

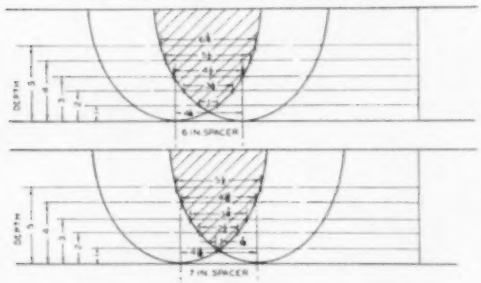


Fig. 1B 16-in. disk at 30-deg angle

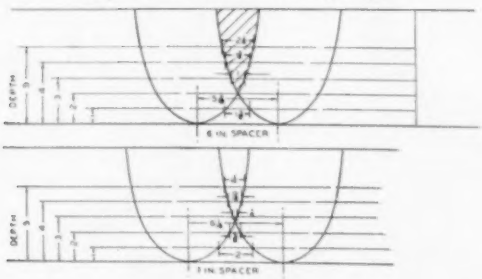


Fig. 2A 18-in. disk at 45-deg angle

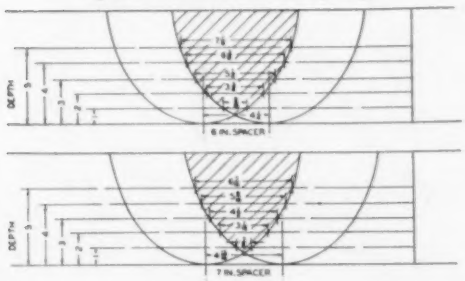
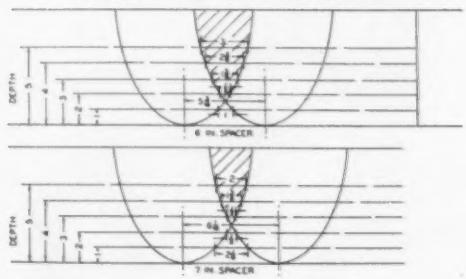
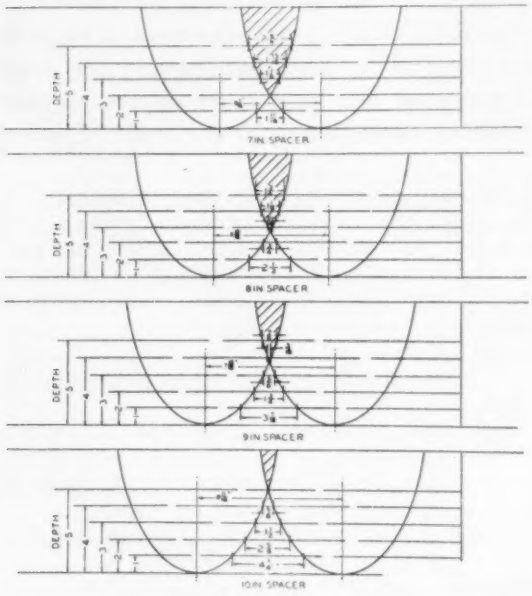


Fig. 2B 18-in. disk at 30-deg angle



. . . Analyzing Disk Cuts

Fig. 3 20-in. disk at 30-deg angle



In the following discussion the reader should bear in mind that the projections illustrating the cuts of the disks would be fairly representative of what happens on smooth fields. However, on rough surfaces it is obvious that it would be necessary to increase the actual depth of operation to compensate for any unevenness so that the machine would make a clean cut across its entire width.

Figs. 3 and 5 are 20-in. diameter disks at 7, 8, 9, and 10-in. spacings at 30 and 50-deg angles. Figure 5 shows that the first two spacings will have a clean cut at one inch but the 9 and 10-in. spacings should be increased to a depth of 1¼ and 1½ in., respectively. When seeding at this setting, the row spacings would be 4½, 5⅛, 5¾ and 6⁷⁄₁₆ in. for 7, 8, 9, and 10-in. spaced disks, respectively.

Fig. 4 20-in. disk at 40-deg angle

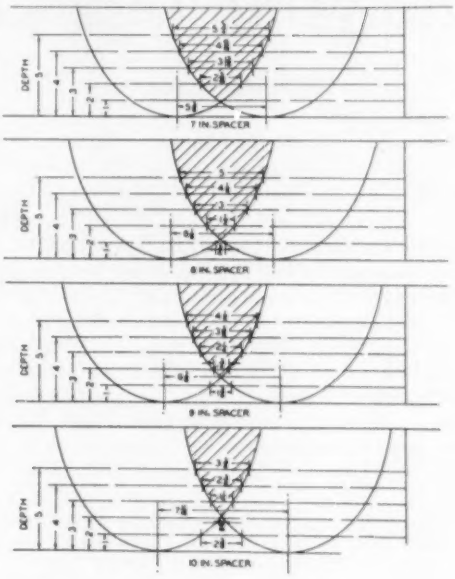


Fig. 3 shows that at a 30-deg angle clean cuts are obtained at depths of 2½, 3¼, 4¼ and 5½ in. for 7, 8, 9, and 10-in. spacings, respectively. For seeding the row spacings would be 6⁹⁄₁₆, 6¹⁵⁄₁₆, 7¹³⁄₁₆, and 8¹¹⁄₁₆ in., respectively.

In comparison to Fig. 3, Fig. 6 illustrates a 24-in. diameter disk at a 30-deg angle. With a 24-in. disk, a clean cut can be obtained at 2¼, 2¾, 3½, and 4½ in. for 7, 8, 9, and 10-in. disk spacings, respectively. Seed row spacing would be 6⁹⁄₁₆, 6¹⁵⁄₁₆, 7¹³⁄₁₆, and 8¹¹⁄₁₆ in., respectively.

From a study of the illustrated figures it is evident that

Fig. 5 20-in. disk at 50-deg angle

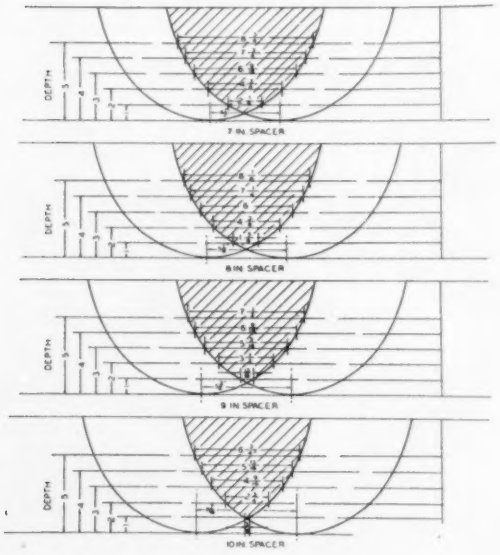


Fig. 6 24-in. disk at 30-deg angle

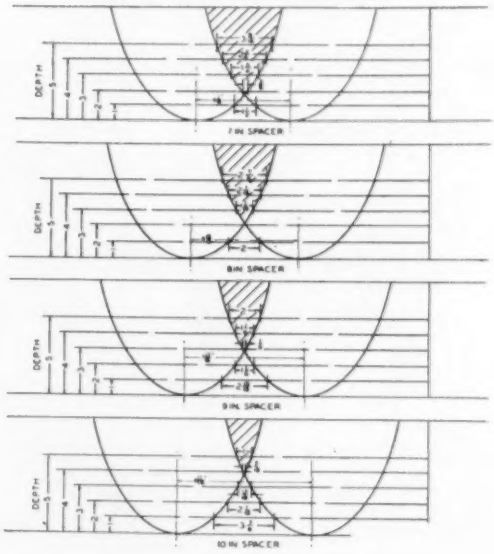
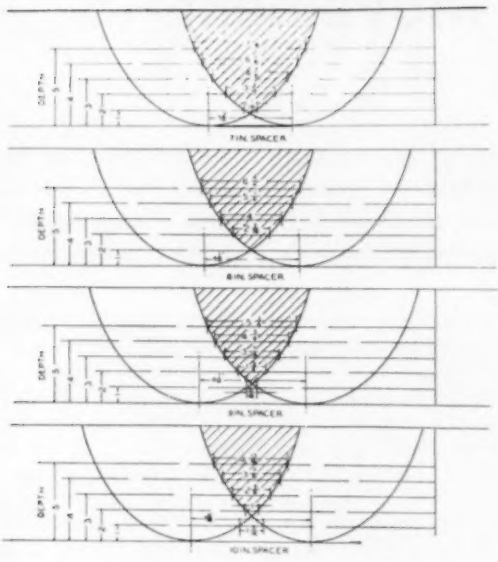


Fig. 7 24-in. disk at 40-deg angle



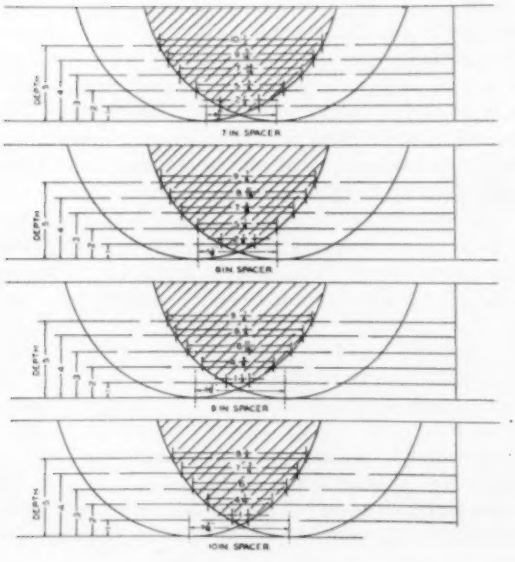
depth of cut has to be increased with an increase in spacing, and with a decrease in disk diameter. The depth of operation required for a clean cut is at a maximum for the 30-deg angle of cut and a minimum for the 50-deg angle of cut. This is true for all spacings studied.

Conclusions

In light of the above remarks and the illustrations the authors would like to make the following suggestions:

(a) In seeding with disk equipment the wide angle setting should not be used where the spacing is greater than 8 in. This is particularly important in areas where swathing is practiced.

Fig. 8 24-in. disk at 50-deg angle



(b) Where clean cuts are necessary to control weeds, and shallow seeding is desirable, the machine should be operated at an angle of cut of 40 to 50 deg.

(c) Where the surface is irregular the machine should be operated at an angle of cut of 40 to 50 deg, and the depth should be increased to secure a clean cut.

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2 Giesecke, F. E., Mitchell, A. and Spencer, H. E. Technical drawing. 3rd Ed., New York, MacMillan Co., 1952.

3 Gordon, E. D. Physical reactions of soil on plow disks. AGRICULTURAL ENGINEERING, 22: 205-208, 1941.

. . . Measuring Effluent

(Continued from page 284)

stallations, an 8-in. aluminum pipe 7½ ft long and a 1-in. copper slotted tube were used. Such an installation is shown in Fig. 4. To obtain a larger capacity at one of the locations, a 10-in. aluminum pipe and 1¼-in. slotted tube were installed in a similar manner. The rating curve was calculated by use of Table 2. Stevens water stage recorders of the continuous roll, weight-driven type were used to obtain a continuous record of the discharge. Time and head scales chosen were 2.4 in. per day and 1 in.=1 in., respectively, both of which have proved satisfactory.

Assuming a recorder error of 0.005 ft and neglecting calibration error, corresponding errors in discharge were determined. With the range of pipe sizes calibrated, it was found that allowable errors of 5 and 10 percent permit discharge measurements down to about 10 and 5 percent of full capacity, respectively. At capacity, the maximum error in discharge is about one percent. With corrugated pipe, some additional error is possible because of variations in inside diameter.

The principal limitation of the slotted-tube flow meter is that it cannot be used to measure flow which carries debris, such as surface runoff or sewage. However, a moderate amount of sediment does not interfere with its operation.

The merits of the slotted-tube flow meter may be summarized as follows:

- It is a relatively simple device. It has no moving parts, which might be subject to binding, sticking, or wear.
- It is not sensitive to minor deviations in fabrication and installation, other than the diameter of the test pipe.
- It can be used to measure a wide range of discharges, including low flows, with good accuracy.
- It has a small head loss.

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2 Donnan, W. W. and Bradshaw, G. B. Tile effluent measuring devices, AGRICULTURAL ENGINEERING, March, 1949.

Internal Atmosphere Movement in CA Apple Storage

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F. W. Southwick, and

J. M. Fore
Member ASAE

The effects of internal atmosphere movement on leakage and breather bag performance under controlled atmosphere conditions in two apple storage rooms reveal importance of proper circulation during storage

THE purpose of this paper is to describe the performance of two CA (controlled atmosphere) apple storages with regard to the effect of internal atmosphere movement on leakage and on the breather bag.

From a study of two CA rooms, Pflug and Southwick (1)* concluded that a breather bag increased the rate of oxygen reduction of a CA storage because it compensated for pressure differences caused by temperature changes and carbon dioxide removal.

According to Pflug(2), in a theoretical analysis, the breather bag will not reduce leakage from pressure differentials induced by evaporator fans.

This study was made on two similar commercial CA storage rooms in Massachusetts. Each of the rooms was 132 ft long, 33 ft wide, and 11 ft high and held approximately 16,000 boxes of apples each. The rooms were lined with aluminum foil and sisal kraft paper laminate. The refrigeration system used ammonia in floor-type evaporators with an intake at the bottom and an outlet at the top connected to a distribution duct. This duct, which extended the entire length of the room, had side openings equipped with regulating dampers and was located to one side of the center of the room because of interference from structural members in the exact center of the room. The normal blower output with the rooms loaded was approximately 34,000 cfm. These rooms were loaded with a clearance of 4 in. on the side walls, 8 in. on the ceiling, and 1 in. on the floor.

There was a 4-in. vertical space from the duct to the outer wall between every two columns of boxes. The cleat ends of the boxes were perpendicular to the central duct. Because of the large crop and the demand for space, there was no center aisle as a return to the blower intake. The breather bags were 19 ft by 7 ft, 8 in. (flat size) and were connected to the rooms through a 5-in. duct.

Procedure and Results

After the rooms were sealed, it was difficult to obtain the 3 percent oxygen level required for the storage of McIntosh apples. In order to help reduce the oxygen content from approximately 17 percent at the time of sealing and to make the most efficient use of the breather bag, approximately 33,600 cu ft of nitrogen were used in the two rooms.

Paper prepared expressly for AGRICULTURAL ENGINEERING. Authorized for publication as Contribution No. 1108 of the University of Massachusetts, College of Agriculture and Massachusetts Agricultural Experiment Station, Amherst.

The authors—J. W. ZAHRADNIK, F. W. SOUTHWICK, and J. M. FORE—are, respectively, associate research professor of agricultural engineering, research professor of pomology, and formerly professor and head of agricultural engineering, University of Massachusetts.

*Numbers in parentheses refer to the appended references.

It was difficult to keep the breather bags from deflating and remaining deflated, even though they were being filled with nitrogen many times a day. However, as soon as the nitrogen was curtailed, the oxygen level in both rooms began to rise. This is evident in Fig. 1, plotted from the storage log, (points along the ordinate are average of each 4 days' analysis). At 18 days in room 5 (22 days in room 6) when nitrogen was curtailed, the oxygen content began to rise immediately. At 30 days in room 5 (34 days in room 6) when nitrogen was added, the oxygen level began to fall. Nitrogen was added until the breather bags inflated. The bags then deflated over a period of 2 to 24 hr, depending on how often nitrogen was added.

At 38 days, it was apparent that the equilibrium oxygen level as defined by Pflug(2) could not be maintained economically with nitrogen through the entire storage season. The rate of oxygen leakage into the rooms without nitrogen was greater than the rate of oxygen consumption by the apples. The equilibrium oxygen level must be equal to or below 3 percent if the oxygen content is to be held at the desired 3 percent level.

In an effort to determine the difficulty in proper functioning of the breather bag and proper rate of oxygen reduction, even though the room was apparently sufficiently airtight for CA storage, static pressures were measured at both ends of the room. At the evaporator and breather bag end of each room, negative pressures up to 0.1 in. water gage were obtained. The negative pressure accounted for the fact that the breather bag, within an hour or less after being filled with nitrogen, became deflated completely. At the end of each room opposite the evaporator and breather bag, up to 0.1 in. water gage positive pressure was obtained. These differences in pressures were believed to be caused by an insufficient return in comparison to a high rate of delivery at the evaporator blower.

At 38 days, all addition of nitrogen to both rooms was stopped. Room 6 was entered using oxygen masks, (storage atmosphere was not lost), and the intake side of the evaporator blower opening was blocked as an emergency method of reducing atmosphere movement until only 0.01 in. water gage pressure remained on the opposite end of the room. Atmosphere movement was reduced from 34,000 to 3,900 cfm. A high rate of atmosphere movement, while important to the rapid cooling of the apples during initial loading of the storage, and also important to the maintenance of proper relative humidity, was not considered essential, since the apples had been cooled to 37 F and humidity was likewise maintained at a satisfactory level. Room 6, with the intake

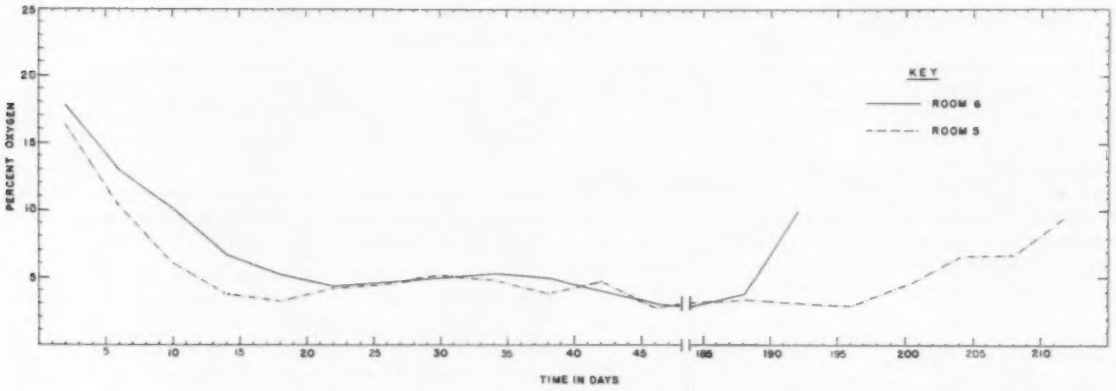

Fig. 1. Storage log shows increase in oxygen when nitrogen is curtailed. At 18 days in room 5 and at 22 days in room 6, nitrogen was curtailed. At 30 days in room 5 and at 34 days in room 6, nitrogen was added. Room 6 was opened for unloading purposes at 188 days. On the 196th day blocking on the intake side of the blower in room 5 was removed. Blower output was reduced on the 204th day and room 5 was opened on the 208th day

blocked, was designated as the treatment. Room 5 was designated as the control.

Referring to Fig. 1, at 38 days, without any addition of nitrogen in either room, and with a reduced rate of air movement in room 6, the oxygen level began dropping in room 6 and began rising in room 5. Since it was obvious that the treatment was effective on room 6, the blower intake in room 5 was also blocked similarly with the same results on the 42nd day.

In room 5, on the 42nd day, nitrogen was also added so that approximately 3 percent oxygen level was reached on the 46th day in both rooms 5 and 6. Nitrogen was not added after this.

Both rooms remained at a relatively constant atmosphere of 3 percent oxygen, 5 percent carbon dioxide, and 92 percent nitrogen and miscellaneous gases, from the 46th to the 184th day.

On the 184th day, room 6 was entered with an oxygen mask (storage atmosphere was not lost), and the blocking on the intake side of the blower was removed. The oxygen level increased immediately, confirming the previous results. Room 6 was opened for unloading purposes at 188 days.

On the 196th day, the blocking on the intake side of the blower in room 5 was removed completely, and the output increased from 3,900 cfm to 34,000 cfm. The oxygen level rose in 8 days from 4 to 6½ percent. On the 204th day, the blower output was reduced to 12,000 cfm, and the oxygen level remained constant at 6½ percent. This air flow condition represents a leakage point just equal to the equilibrium oxygen level. On the 208th day, room 5 was opened for unloading.

Summary and Conclusions

The behavior of two CA apple storages of equal capacity and identical construction has been described throughout an entire storage season. Breather bag performance and changes in atmosphere composition brought about through the addition of nitrogen and through the decrease in the rate of atmosphere movement has been discussed.

The relationship of method of loading and a high rate of atmosphere movement resulted in a positive differential pressure across the wall of 0.1 in. of water at the end of the room opposite the evaporator and a negative pressure of 0.1 in. of water at the evaporator end of the room. This 0.1-in. differential pressure across the wall caused continuous air movement out at one end of the storage room and in at the other end. The rate of leakage was much greater than the capacity of the fruit to consume oxygen, thus raising the oxygen level.

The differential in pressures created by a high rate of atmosphere movement in comparison to an insufficient return resulted in deflation of the breather bag.

These results indicate that CA rooms must be designed to achieve proper circulation and cooling without the use of high velocities, which result in differential pressures in the room.

References

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Nuclear Energy Institutes

NINE institutes on nuclear energy for engineering educators will be held throughout the nation during June 23 to August 22 under the sponsorship of the Atomic Energy Commission and the American Society for Engineering Education. The purpose of the institutes is to provide special training in the fields of nuclear energy and the nature of nuclear reactor problems so the teachers can incorporate this material in their teaching programs.

The institutes will include four basic courses for teachers with no special background in nuclear energy, four advanced-level courses and one basic course for teachers in technical institutes. The course for teachers will be held at Pennsylvania State University from June 30 to August 8 and at Argonne National Laboratory from August 11 to 22.

Applicants will be selected on the basis of the candidate's experience and instructional use to be made of the training. Applications for appointment may be obtained from deans of engineering or from ASEE headquarters and sent to W. Leighton Collins, Secretary of ASEE, University of Illinois, Urbana, Ill.

. . . Soil Compaction

(Continued from page 281)

toes and sugar beets planted with relatively narrow row spacing.

Therefore, in Germany the recommendation is made to the farmer that in case he is not able to buy a second lighter tractor, he should buy a second pair of wider tires for his one tractor. The standard tires may be 7 to 9 in. wide with an inflation pressure in the field of 12 to 20 psi. The additional tires of the same diameter may be 10 to 12 in. wide with an inflation pressure of 8 to 12 psi. The two sets of tires may be used on wet soils as twin tires with very low inflation pressure.

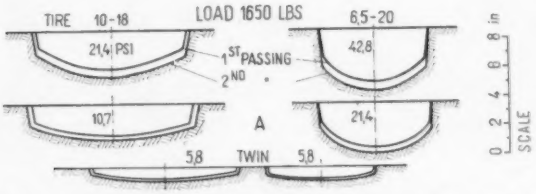

Fig. 15 Track depth under narrow, wide and twin trailer tires at different inflation pressures

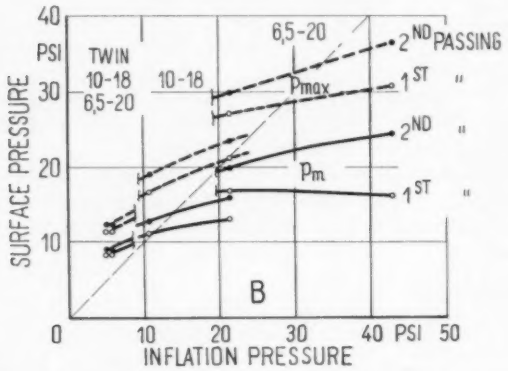

Fig. 16 Pressure in the contact area under narrow, wide and twin trailer tires at different inflation pressures

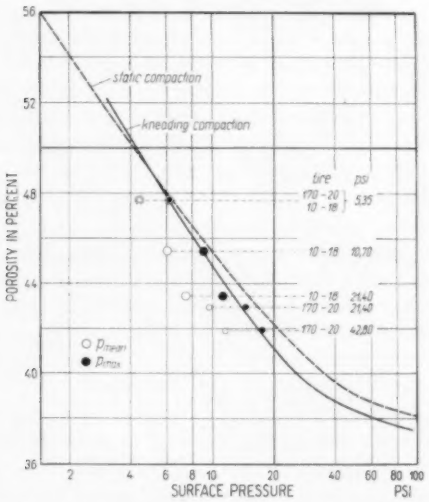

Fig. 17 Soil compaction under narrow, wide and twin trailer tires at different inflation pressures compared with static and kneading compaction

As two sets of tires are rather expensive, the German farmer often uses "Gitterraeder" (cabbage wheels). These wheels in addition to the tire are advantageous when the surface of the soil in the spring has dried to a depth of 3 to 4 in. but is still at a high moisture content underneath. Whereas narrow tires in this case cause deep tracks and high compaction in the deeper soil layers, twin tires or tires with "Gitterraeder" produce only small track depths.

Finally, it should be indicated that the inflation pressure is not identical with the surface pressure in the contact area. Fig. 15 shows as an example the measured track depths under different trailer tires with a load of 1650 lb, travelling on a fine sandy loam at 19 percent moisture content and 50 to 52 percent porosity.

The mean pressure p_{mean} was calculated from the measured contact areas and is shown in Fig. 16. It is known that from earlier pressure measurements under tractor tires without high lugs that the maximum pressure, p_{max} equals 1.4 to 2 of p_{mean}. It should be noted that the maximum and mean pressures are smaller than the inflation pressures when narrow tires produce deep tracks. The maximum and mean pressures under the wide tire and the twin tires with low inflation pressure, however, are higher than the inflation pressure. Fig. 17 shows the measured porosity (average value of eight measurements) in relation to the mean and maximum pressure. The soil is compacted by different pressures under tires in the same manner and follows the same principles as the kneading compaction test.

Summary

Based on the formulas of Boussinesq and according to O. K. Froehlich, the pressure distribution in soil was represented in relation to the concentration factor, ν, for different soil conditions. According to Froehlich's formulas, the bulb-shaped curves under different large tires with different loads and under one tire at different soil conditions were calculated. In addition, the pressure distributions under different large trailer tires and twin tires with different inflation pressures but the same load were theoretically determined. The pressure in the upper soil layer is determined by the specific pressure at the surface, which depends upon the inflation pressure and the soil deformation, *i.e.*, the size of contact area. The pressure in deeper soil layers is determined by the amount of the load.

Furthermore, the principles of static and kneading soil compaction were shown. According to these, the porosity decreases with the logarithm of the applied pressure.

Compaction and plastic flow increase similarly with increasing water content.

Measurements of porosity under tires with different surface pressures showed that soil compaction under rolling tires follows the same basic relation to the pressure in the contact area as soil compaction during static or kneading compaction tests.

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1 Froehlich, O. K. Druckverteilung im Baugrunde (Formulas of Boussinesq). Vienna, 1934.

2 Soehne, Walter. Druckverteilung im boden und bodenverformung unter schlepperreifen (Distribution of pressure in the soil and soil deformation under tractor tires). Grundlagen der Landtechnik, Heft 5, 1953, S. 62.

COMMENTS ON DR. SOEHNE'S PAPER

By Dr. L. Karafiath, Headquarters, Ordnance Tank-Automotive Command, Detroit Arsenal, Centerline, Mich.

THE paper presented by W. Soehne at the Golden Anniversary Meeting of the American Society of Agricultural Engineers is concerned with the disadvantages of soil compaction caused by agricultural tractors.

The first part of the study gives an excellent presentation of pressure distribution under wheels based on well established principles of soil mechanics. The author recommends Froehlich's equation, which contains the so-called "concentration factor," in order "to calculate pressure distribution in soils with different moisture content, cohesion and density." However, as no relationship is known between these properties of soil and the above factor, which considerably affects stress distribution, a practical application of this suggestion appears entirely uncertain. Therefore, the approach to the problem is more qualitative than that suitable for definite computations.

Pressure distribution is also affected by loading conditions. If load is close to, or exceeds, the bearing capacity of the loading area, stress distribution determined by plasticity theories is entirely different from that determined by Froehlich's equations. Consequently, loading conditions have to be also considered if more realistic picture of pressure distribution is expected.

Although the objective of Dr. Soehne's paper does not include discussions on wheel performance in general, and it is rather limited to the unfavorable effect of compaction, it would appear that the presentation of the problem would gain if it were referred to general principles of land locomotion as outlined in Bekker's work on "Theory of Land Locomotion" (University of Michigan Press 1956). This, especially, refers to the computation of sinkage, which affects not only wheel performance, but also the settlement of any ground contact area, and hence the compactive effect of loaded tires.

The second part of the study is concerned with general principles of soil compaction as applied to the compaction by tires. This type of operation is widely known in the United States, where many of the large earth structures have been built by using this method. Similarly, road and airfield subgrades also have been often compacted by rolling.

The question of tire shape, and inflation pressure also has been investigated by Dr. Soehne from the viewpoint of soil compaction. The author recommends that the weight of tractors and compacting machinery should be further reduced, and that wider tires with a lower inflation pressure should be used. As far as the compaction is concerned, the above conclusions appear to be true, but it seems to be inadvisable not to mention the problem of wheel performance; wider tires mean more rolling resistance, more power and weight. These relations should not be overlooked if a correct interpretation of test data and recommendations is expected.

Author's Reply to the Comments by Dr. L. Karafiath

In answer to paragraph 2, Dr. Karafiath's comments, I have mentioned that the calculation of pressure distribution does not claim to give exact values in all cases. The figures shown will give only an impression how we must visualize the relation between the pressure distribution and the wheel load, tire-dimensions, tire inflation pressure and different soil conditions. Especially for the influence of wheel load the pressure distribution will give not only qualitative, but also quantitative values. However, further investigations on measurements in comparison with calculation on the pressure distribution in the soil shall follow in order to be able to select the actual concentration factor with a higher certainty.

My answer to paragraph 3 is that if the wheel load exceeds the bearing capacity of the loading area, the wheel will consequently sink deeply into the soil, eventually down to the axles. This case is not really important to the question of soil compaction as normally the farmer does not drive on such ground considering the risk of getting stuck. As the pores in this case are mostly filled with water, the compaction will not be as great as when the soil has optimum moisture content for compaction.

Within a relatively short paper it was not possible and it was not the purpose to discuss the wheel performance in general. But about this there are several publications from American, English and German authors, also from the author himself. My first investigations (2)* were published in 1953; the excellent book by M. G. Bekker, "Theory of Land Locomotion," had not been read by the author when this paper was prepared.

From measurements by many authors it is known that the rolling resistance of wider tires with a lower inflation pressure and also of twin tires with a very low inflation pressure is smaller in most cases on a soft soil and the pulling force is higher. But I agree that several other points have to be considered besides the soil compaction to choose the right dimension of tractor tires for each different purpose.

*See reference No. 2 in article.

Agricultural Machinery Testing Organization Formed in Canada

A NEW agricultural machinery testing organization has been announced by the Saskatchewan Government to provide a testing service to guide Saskatchewan farmers in the selection of agricultural machinery. It is reported that the organization would work in complete cooperation with manufacturers of farm machinery, with field testing designed as an extension of research and testing carried out by the companies themselves, thereby providing more specific information on adaptability to Saskatchewan conditions.

The organization will be staffed with professional agricultural engineers, who will carry out the actual testing of new agricultural machinery under varying conditions in the province, working with the University of Saskatchewan and other research agencies. Results of tests will be available to the public.

It has been announced also that J. T. Kyle, member of ASAE, has been appointed as director of the new organization. In addition to being named director of machinery testing, Mr. Kyle has also been appointed as chairman of the Saskatchewan Implement Engineering Committee. He joined the permanent staff of the agriculture department of Saskatchewan in 1948 as an agricultural extension engineer, was appointed head of the operations and equipment division of the conservation and development branch in 1949, and has since been engaged in large-scale land reclamation projects throughout the province.

Immediate plans do not call for testing all farm machinery on the market today, but only those machines that have exhibited bad design features and have given problems to farmers. The report states that the testing organization will not attempt to influence the judgment of farmers in their machinery purchases but will present facts, based on actual field tests in various areas, to enable farmers to make their own selection to fit their individual requirements.

In operation the program, in general, progresses in the following manner: After a particular problem machine has been located and a unit obtained, the manufacturer of the machine in question is asked to consult with the testing board in drawing up a test technique that will suitably test the performance and design of the unit. This may involve test work at a number of locations, as well as basic laboratory and fatigue testing. Depending on the machine, a test team of engineers carrying out the test might take from two weeks to two months to accumulate the necessary data such as production rates, capacities, power requirements, design calculations and strain-gage work. An additional two months may be required for developing the most suitable test techniques. General recommendations will be made by the board. The manufacturer is then given an opportunity to indicate in writing his statement with regard to what he is prepared to do immediately to correct any faults that may have shown up on the tests. The complete report of the test procedure results then will be made available to the public.

Mechanical Mouse Aids Research in Subsurface Drainage

C. D. Busch
Assoc. Member ASAE

Strain gage actuated measuring instrument shows promise as an aid to engineers in drainage research

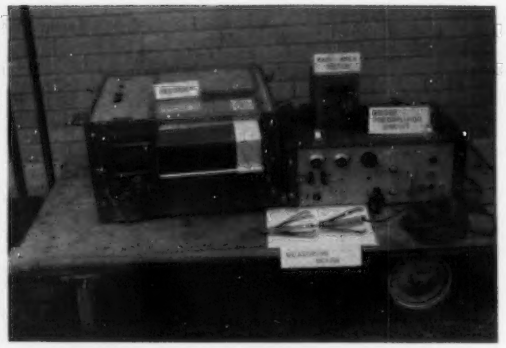


Fig. 1 Instrumentation for recording area measurements

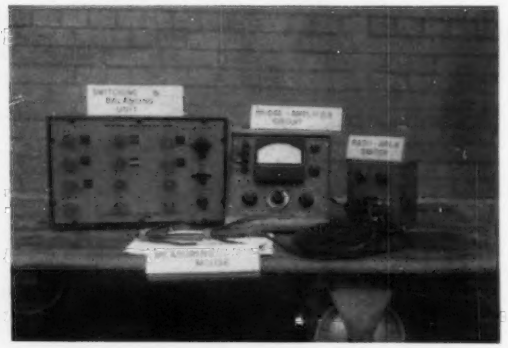


Fig. 2 Instrumentation for single radii or area measurements

A FUNDAMENTAL problem in drainage research is the measurement of the cross-sectional area within a subsurface drain. This problem is most acute in the investigation of bare earth channels (mole drains) and plastic or cement reinforced earth channels. Use has been made of plaster of paris casts and inspection holes in past mole drainage research(1)*. Unfortunately, such procedures destroy the drain, preventing continued observation. In plastic-lined drains minimum diameter measurements have been made using various size eyebolts attached to ½-in. steel tubing and inserted from the outlet end(2). In studies of plain and plastic-lined drains at Cornell University an instrument was devised to give more information on the condition of the drain and its changes in shape.

Figs. 1 and 2 show the developed instrumentation. The "measuring mouse," which is pulled through the drain on a small wire, has strain gages mounted on the rear set of spring fingers. These gages measure the changes in resistance that occur when the fingers are compressed (*e.g.* the channel changes in shape or size) and can be read singly to give radial distance, or as a group to give a measure of

INSTRUMENTS NEWS (Karl Norris, Editor) is sponsored by the ASAE Committee on Instrumentation and Controls. Contributions on agricultural applications of instruments and controls and related problems are invited, and should be submitted direct to K. H. Norris, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

The author—C. D. Busch—is agricultural engineer, (SWCRD, ARS) USDA, Ithaca, N. Y. The project is in cooperation with the agricultural engineering department, N. Y. Agricultural Experiment Station, Cornell University, Ithaca.

*Numbers in parentheses refer to the appended references.

SIMPLIFIED CIRCUIT DIAGRAMS

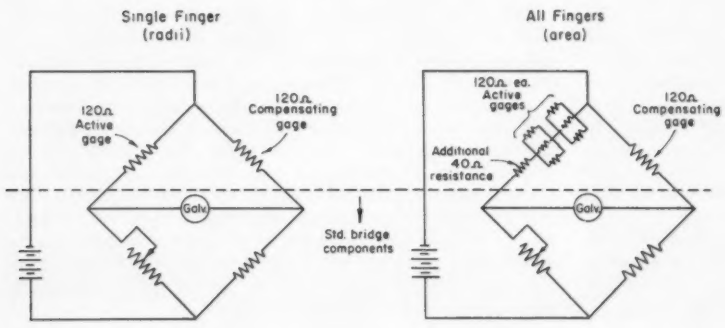
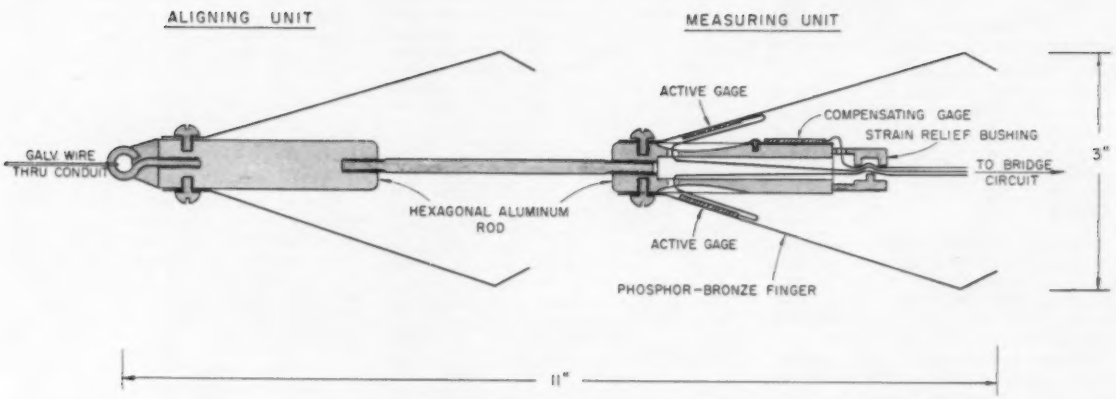


Fig. 3 Basic Wheatstone bridge diagrams used for determining individual radii at left and cross-sectional area at right

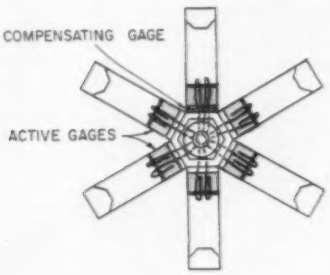


the cross-sectional area. Shown in Fig. 1 is the configuration for continuous recording of area measurements; in Fig. 2 the configuration used for measuring individual radii or areas.

The simplified circuit diagrams (Fig. 3) display the basic Wheatstone bridge arrangements as they are used for both types of measurements. The portions below the dashed line are the commercially available components. As the active gages are compressed they become shorter and fatter, lowering their electrical resistance; when they are elongated they become longer and thinner, increasing their resistance. The galvanometer indicates these resistance changes and a suitable calibration converts the readings to length or area measurement. The compensating gage eliminates temperature effects from the resistance readings.

The "mouse" (dissected in Fig. 4) is designed to measure drains between 1 and 3-in. in diameter. It is made in two sections, the front serving only for channel alignment. The chassis is made of hexagonal aluminum rod to reduce the overall weight. The spring fingers, to which the strain gages are attached, are made of 0.018-in. phosphor-bronze. Their ends are bent to allow the instrument to make short reverse movements. The strain gages, SR-4, type A-5-1, were attached while the fingers were approximating a 2-in. diameter to reduce by one-half the compressive stress on the gage. This was found necessary to keep the lead-gage wire connection from breaking under the high amount of finger deflection encountered. It is also necessary to have a moistureproof coating over the gages for protection against the damp channel conditions. The wires which connect the strain gages to the other bridge components pass through a strain relief bushing to permit using them for pulling the "mouse" backwards. These wires are marked with tape at 1-ft intervals to allow the distance travelled to be referenced with respect to the end of the drain.

In current field operations the "mouse" is first pulled through a drain at roughly 5 fpm while connected to the instruments for recording area. The recording graph paper is also marked by manual control as each tape mark enters the



REAR VIEW

Fig. 4 Schematic views of "measuring mouse" show positions of both aligning and measuring units. Rear view shows the number of radii and strain gages used

drain. When the run is completed the distance to the two smallest and two largest areas is noted and the "mouse" rerun through the drain connected for individual measurements. At each of the four positions noted, the six radii are measured to give a picture of the drain cross section.

The "mouse" is easily calibrated by inserting it into pipes of known diameter. When so calibrated, it was found to measure accurately to the nearest 0.1 in. over the radial range. If found desirable, this precision can be improved, since current usage has not taxed the strain-gage's sensitivity.

The primary application of the "measuring mouse" has been in the study of drain deterioration. The instrument will also be used to study deflections of plastic and mole drains under various loads. Its main advantage in drainage investigations is a minimum of disturbance to the channel; only the thin wire used for pulling the instrument remains in the drain. With small design modifications, similar strain gage measurement could also be used to study tile alignment and separation.

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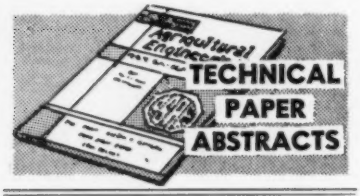


Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. Information concerning copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Mich.

Poultry House Cooling, by Robert C. Jaska, assistant professor of agricultural engineering, A & M College of Texas. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December 1957, on a program arranged by the Electric Power and Processing Division. Paper No. **57-615.**

Basic research on the effect of environmental temperature on laying hens indicates that the sharpest decline in egg production occurs when temperatures exceed 80 F and that light breed hens can withstand higher temperatures than heavy breed hens.

This paper reports on the studies and the results of these studies conducted at the Texas A & M College and at several poultry farms in Texas on several methods of cooling on both light and heavy breed hens. These tests include fogging systems, conventional evaporative coolers, evaporative pad and fan systems, and control conditions.

Results of these tests indicate that fogging systems reduced mortality in both the light and heavy breed hens, but showed no appreciable effect on egg production. Tests conducted with conventional evaporative coolers were not conclusive because of rapid pad deterioration. The pad and fan installations gave the lowest temperatures of any systems studied.

Selected Intense Storms in Little Sioux River Subwatersheds, by H. P. Johnson and R. K. Frevert, respectively, research associate, Iowa State College, and assistant director, Iowa Agricultural Experiment Station. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-538.**

Hydrologic studies initiated in 1950 on several agricultural watersheds in the steep loess area of western Iowa are described in this paper. Details of physical features of the watersheds, instrumentation, and a description of three unusual storms are presented. The objectives of the studies are to obtain design information on storm runoff for conservation structures and to determine the effect of structural treatment and land treatment on storm runoff.

Grain Drying with Solar Heat, by Fred Buelow, assistant professor, Michigan State University, East Lansing. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged jointly by the Electric Power and Processing and Farm Structures Divisions. Paper No. **57-602.**

The results of one season of drying corn with two solar grain drying units are reported. The drying characteristics of the solar units are compared with unheated air drying. The test results indicate that solar units had drying rates about three times that of an unheated air drier on sunny days. The test results also showed that a glass unit transferred 84 percent of the solar energy falling on it to the air passing through it, while a unit without glass had an efficiency of 45.6 percent.

Drainage Research in Colorado, by N. A. Evans and A. R. Robinson, respectively, head agricultural engineer, Colorado State University, and agricultural engineer, ARS, Fort Collins, Colo. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-543.**

This paper summarizes some of the research on drainage which has been completed or is in progress in Colorado. The results of a model study concerned with interceptor drainage and two field studies, one on interceptor drains and the other on analyses of drainage problems in the Upper Colorado River Basin are discussed.

The model study which was conducted in a large tilting flume was for the purpose of determining the shape of the drawdown curve and flow resulting from the installation of an interceptor drain. Information, utilizing idealized conditions, was gathered on the hydraulics of this type of drainage. Analytically derived relationships were checked as to their adequacy and correctness using the results of the model study.

The reported field study on interceptor drains was for the purpose of developing general design criteria. Measurements were made on several field installations of the physical and soil features, water supply and drain flow, hydraulic conductivity and water table position. Utilizing these data, methods are being evolved for predicting tile flow and for design of future installations for maximum benefit. Previous model study findings and analytically derived relationships are being adapted for field use.

Some phases of an extensive study aimed at developing improved methods of diagnosing drainage problems and selecting the best treatment or preventive measures are reported in a third section. The economic and physical feasibility of pump drainage for an area is discussed. The hydraulic characteristics of an aquifer as determined by a pumped well are presented.

Sociological Aspects of Farm Work Efficiency, by R. L. Eichhorn, associate professor in sociology, Purdue University, Lafayette, Ind. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a special Farm Work Efficiency Program. Paper No. **57-622.**

The sociological aspects of farm work efficiency are many and varied. As an illustration of the scope of this field of study one small area has been selected, sociological factors in the adoption of a new farm practice. The adoption of a new farm practice may often make the difference between a profit and a loss in the farm business; it may be accompanied by increased efficiency in the use of labor or taking the drudgery out of farm work.

The paper points out that the adoption of a new technique is associated with several sociological factors including education, sources of information, cultural group, family structure, and position in the community. The acceptance of the four-row corn planter is used as an example of a new technique and the effect of the sociological factors, particularly health, is discussed.

This work forms a part of the Purdue Farm Cardiac Project, Purdue Agricultural Experiment Station Project 712. Data in the Purdue Farm Cardiac Project also include information on the health status and age.

Steering Forces of Farm Tractors, by J. B. Liljedahl, R. Gluck, and M. Schroeder, respectively, associate professor of agricultural engineering, Purdue University; engineer, United States Rubber Co.; and instructor, agricultural engineering department, Pennsylvania State University. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Power and Machinery Division. Paper No. **57-514.**

This paper presents the results of investigations at Purdue University on the human forces required to steer farm tractors. Only large row-crop tractors were studied. The effect of three types of drivers to improve upon the steering were studied. Tests were performed while cultivating corn, driving over 5-in. bumps and using a front end loader. The primary purpose of the investigations was to assess the working conditions of tractor drivers with particular emphasis on those with impaired hearts.

SR-4 strain gages were used to sense the torque in the steering wheel. From the oscillographic record, the average and maximum steering forces were determined. When the tractor was equipped with a four-row cultivator, it was found that power steering as compared with manual steering reduced average steering forces by 41 to 50 percent and that the maximum forces were reduced 50 to 78 percent. Other results include average and maximum steering forces while using a loader; cycle time when tractor was loading manure; shock forces when a large row crop tractor was driven over angled 5-in. bumps; use of a shock absorbing brake on the steering wheel; and when a large, manually steered, tricycle-type tractor was equipped with independently suspended front wheels.

This work forms a part of the Purdue Farm Cardiac Project, Purdue Agricultural Experiment Station Project 712, cosponsored by Purdue University, Indiana Heart Foundation, American Heart Association, Indiana State Board of Health and the National Institute of Health.

Some Suggestions for Combining Engineering Management and Marketing in Successful Farming, by W. H. Yaw, Farm Clinic, West Lafayette, Ind. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Farm Structures Program Division. Paper No. **57-561.**

A discussion is presented in support of advancing the idea for pre-engineered farm building systems into rural-processing or in-the-area development of small businesses. These are to be done with the cooperation, aid and assistance of large manufacturing and farm organizations. In this way it is suggested that the area development of the agricultural problem be attacked in a genuine free enterprise manner which covers not only the farm but the rural area surrounding the farm—in order that areas threatened with dilapidation can grow and flourish.

Moreover it explains that as more industrial uses for farm products enter the horizon, the rural processing industries will be in a position to capitalize on the challenging and exciting new frontiers, and other corporations will be able to sell the materials needed to develop these rural processing industries.

New SAAE and VA Officers

A meeting of the Southern Association of Agricultural Engineering and Vocational Agriculture was held jointly with the southern deans and directors of agricultural instruction at Oklahoma State University, April 3. New officers elected for the SAAE and VA are as follows: president, E. T. Swink, head, agricultural engineering department, Virginia Polytechnic Institute; vice-president, T. G. Walters, supervisor, vocational agriculture, Georgia; fiscal officer, C. C. Scarborough, teacher training department, North Carolina State College; secretary, A. W. Snell, head, agricultural engineering department, Clemson Agricultural College.

New FEI Executive Secretary

An announcement has been made that Douglas Hewitt of St. Paul, Minn., has been appointed as executive secretary of the Farm Equipment Institute. Mr. Hewitt succeeds Robert A. Jones who is retiring after nearly 39 years with FEI.

The new FEI secretary was formerly an executive with the Minnesota Employers' Association and, before that, with Associated Industries of New York and has a further background in business and public relations. During World War II he was an infantry soldier and officer, and served as general staff officer for supply in the Chinese 13th Army.

Mr. Hewitt holds a B.S. degree from Colgate University, an M.S. degree from Cornell University, and has done graduate work in both Yale University and Syracuse University.

International Engineering Meetings

There will be held in Canada and the United States during September 1958, a series of international meetings and tours of importance to engineers. The "package" meetings and dates are: September 3-6, fifth convention of the Pan American Federation of Engineering Societies at Montreal, Canada; September 7-11, sectional meeting of the World Power Conference in Montreal; September 11-14, study tours to St. Lawrence River navigation and power projects, to Niagara Falls, to the Nuclear Power Station at Shippingport, and to New York City; and September 15-20, sixth International Congress on Large Dams at the Statler Hotel in New York City.

Additional information may be obtained by writing to the chairman of the Committee on International Relations, Engineers Joint Council, G. A. Hathaway, Chairman, 4316 Van Buren St., University Park, Hyattsville, Md.

Becomes Life Member

The Council of ASAE recently conferred the grade of Life Member upon John L. Burgan in recognition of distinguished service, under provisions of Article B5 of the Society's By-Laws. Mr. Burgan retired in 1955 as director of rural development of The New York State Electric & Gas Co. after 25 years of service in various capacities. He was engaged in farm electrification and was prominently identified with Cornell University and the Edison Electric Institute. He also took an active part in publication of three important farm handbooks and manuals on farm electrification, and he played a leading role in the organization of the farm group of the Edison Electric Institute.

In his early years he worked for the Vinton Colliery and Delano Coal Co. at Vintondale, Pa., for 19 years before being associated with the Pennsylvania Electric Co., Johnstown, Pa. In 1935 he joined the New York State Electric & Gas Co., as securities manager, and was later in charge of rural development. He was made director of rural development in 1937.

New Central Illinois Section

Thirty-five members were in attendance at the organizational meeting of the new Central Illinois Section of ASAE, held May 1 at Lincoln. The principal address was given by ASAE President E. D. Anderson, director of agricultural extension, Stran Steel Corp., who spoke on recent developments in society sections. J. L. Butt, executive secretary of ASAE followed with an illustrated talk on the national office of the Society and its services. The new officers elected were: R. C. Hay, professor of agricultural engineering, University of Illinois, chairman; L. O. Stoeber, sales engineer, Dunbar Kapple, Inc., A. R. Ayers, Central Illinois Mfg. Co., and R. E. Reeves, director of engineering, Decatur Pump Co., vice-chairmen; and secretary-treasurer, Floyd Herum, agricultural engineering dept., University of Illinois. K. E. Fuller, president, Fuller Seed Co., was also named a member of the executive committee. A nominating committee consisting of D. L. Searls, Camp Point; F. W. Andrew, Champaign and R. P. Stewart, Peoria was also elected.

The first regular meeting is tentatively planned for September in Peoria. At that time the by-laws of the Section will be adopted.

(Continued on page 312)

President Earl D. Anderson *(left)* is shown presenting R. C. Hay, newly-elected chairman of the Central Illinois Section, a copy of a Section manual. Watching in background *(left to right)* K. E. Fuller, member of executive committee; L. O. Stoeber, vice-chairman; F. L. Herum, secretary-treasurer; and J. L. Butt, executive secretary of ASAE

EVENTS CALENDAR

May 19 — A regional meeting of *Engineers Joint Council*, sponsored locally by the Western Society of Engineers, will be held at the Sherman Hotel in Chicago, Ill. For further information contact either Engineers Joint Council, 29 W. 39th St., New York 18, N. Y., or Western Society of Engineers, 84 E. Randolph St., Chicago 1, Ill.

May 19 - June 14 — Observance of *Rural Electrification Administration's 23rd Birthday*. The aim is to encourage a stepped-up sales program for electrical appliances and equipment, household wiring and rewiring, and farm and home water systems. For further details write REA, USDA, Washington 25, D.C.

May 22 — Spring Industry Meeting, *Farm Equipment Institute*, LaSalle Hotel, Chicago, Ill. For details write FEI, 608 S. Dearborn St., Chicago 5, Ill.

June 9 - 12 — *American Society of Mechanical Engineers* Conference on Materials Handling, Public Auditorium, Cleveland. For information write Clapp & Poliak, Inc., 341 Madison Ave., New York 17.

June 11-14 — Annual meeting of the *National Society of Professional Engineers* in the Chase-Park Plaza Hotel at St. Louis, Mo. For further information write Kenneth E. Trombley, National Society of Professional Engineers, 2029 K St., N.W., Washington 6, D.C.

June 16-20 — 66th Annual Meeting of *American Society for Engineering Education*, University of California, Berkeley, Calif. Contact W. Leighton Collins, Sec., ASEE, University of Illinois, Urbana, Ill.

June 17-20 — Joint meeting of the *American Grassland Council* and the *American Dairy Science Association*, Raleigh, N. C. For further information write to Z. W. Craine, Sec'y-Treas., American Grassland Council, P.O. Box 30, Norwich, N. Y.

June 23-27—Twelfth technical *Photographic Exhibit* of the American Society for Testing Materials, Hotel Statler, Boston, Mass. Further information may be obtained from E. W. Walsh, chairman, ASTM Photographic Exhibit, the Narrangansett Electric Co., 15 Westminster St., Providence, R. I., or the Headquarters of the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

June 29 - July 11 — *Short Courses on Materials Engineering Design for High Temperature* at Pennsylvania State University to keep design engineers and others engaged in research on materials abreast of new development in the field. For further details contact Joseph Marin, Engineering Mechanics Dept., Pennsylvania State University, University Park, Pa.

(Continued on page 316)

51st Annual Meeting of ASAE

Santa Barbara Campus, University of California — June 22-26, 1958

The 51st Annual Meeting of ASAE will be held June 22-26 at the Santa Barbara College campus of the University of California's "Campus with a Seashore" in the center of an agricultural district where are located cattle ranches, citrus and vegetable farms, packing plants, mechanized ranches and other phases of interest for the observation of the engineer. Along with the strong technical program planned for the summer meeting, the Pacific Coast Section of ASAE reports that the 408-acre ocean front site, located at the foot of the Santa Ynez mountain ranges with a full view of the Pacific Ocean, is in itself a vacation attraction. The spacious beaches and pool afford excellent opportunities for swimming and sun bathing. Wives and children will be entertained with special programs during the four-day stay which will include a ladies' luncheon, coffee hour, golfing, weiner roast, movies, beach games, roller skating, and tours.

Among the highlights of the program will be a Sunday night opening get-together and buffet dinner; agricultural engineering tours scheduled for Tuesday afternoon; the off-campus Spanish barbeque, Tuesday night; and the annual dinner Wednesday night.

Advance registration cards and hotel reservation forms have been mailed to ASAE members. Non-members interested in attending the meeting should communicate with the central office of the Society at St. Joseph, Mich., for information on accommodations and the program of the meeting sessions.

Power and Machinery Program

The Monday morning session will include discussions on present day use of computers for scientific calculations, by R. R. Brown, International Business Machines Corp.; applying a digital computer to farm tractor design, by H. W. Van Gerpen, Deere & Co.; modern irrigation equipment, by J. R. Davis, University of California, and field measurement of tractor transmission forces, by A. Gerlach, Institute for Tractor Research, German Federal Republic, translated and presented by W. H. Worthington, Deere & Co.

Papers to be presented during the afternoon session are: "Application of Continuous Mechanics to Soil Compaction," by G. E. VandenBerg, L. E. Malvern, and W. F. Buchele, Michigan State University; "New Aspects of Tractor Performance," by M. G. Bekker, Detroit Arsenal; "Measurement of Tire Slippage," by J. Bruwer and G. W. Steinbruegge, University of Nebraska, and "Measurement of Forces on Track Shows," by I. F. Reed, National Tillage Machinery Laboratory.

Topics to be covered Tuesday morning will include "Rotary Tillage Characteristics" by W. J. Adams, Jr. and D. B. Furlong, Food Machinery and Chemical Corp.; "Design Factors in a Spring Trip Beam Assembly for Moldboard Plows," by O. E. Johnson, International Harvester Co., and "Energy Requirements for Cutting Forage," by W. J. Chancellor, University of California.

The Power and Machinery program will be concluded on Wednesday morning with discussions on power requirements of a combine cylinder when threshing solid and hollow stemmed varieties of wheat, by F. Bigsby, Experimental Station, Saskatchewan; harvesting edible beans in Michigan, by H. F. McColly, Michigan State University; a mechanical harvester for green asparagus, by R. A. Kepner, University of California, and mechanical fruit harvest — olives, peaches and pears, by L. H. Lamouria, H. T. Hartman, R. W. Harris, and C. R. Kaupke, University of California.

Soil and Water Program

Hydrology Group — For the Monday morning session W. L. Berry, Department of Water Resources, Sacramento, Calif., will discuss the California water plan; H. O. Matson, SCS, USDA, will speak on performance of flood prevention works during 1957 spring floods; E. J. Workman, New Mexico Institute of Mining and Technology, will present the topic, "The Problem of Weather Modification," and the use of watershed characteristics in hydrograph synthesis for small arid land watersheds, will be discussed by R. B. Hickok, Holmes & Narver, Inc., Robert V. Keppel, ARS, USDA, and B. R. Rafferty, University of Texas.

Soil Erosion Group — Four topics will be discussed in the Monday afternoon session: "The Effect of Cropping and Tillage on Runoff and Erosion in the Palouse Area," by L. M. Naffziger, and G. M. Horner, ARS, USDA; "Relation of Plant Cover to Infiltration and Erosion in Ponderosa Pine Forests of Colorado," by E. J. Dortignac, Rocky Mountain Forest and Range Experiment Station; "The Erosion Hazard in Obtaining Increased Water Yields on Dry Lands," by R. H. Burgy, University of California, and "Erosion Losses from Surface Irrigation," by S. J. Mech, ARS, USDA.

Drainage Group — Discussions for Tuesday morning will be on drainage and ground-water problems in the Arizona-Southern California irrigated areas, by C. L. Sweet, Bureau of Reclamation, Boulder City, Nevada; construction methods, equipment and procedures of laying deep tile and irrigated lands, by M. Ray Parsons, SCS, USDA; reclamation potential of submerged marine and delta sediments, by V. S. Aronovici, ARS, USDA, and soil and engineering investigation necessary for drainage on irrigated lands, by J. C. Walker and L. J. Allsop, Bureau of Indian Affairs, Phoenix, Arizona.

Irrigation Group—The concluding session of the Soil and Water Division will be held on Wednesday morning and will include papers on flow regimes in surface irrigation, by Lloyd E. Myers, Jr., ARS, USDA; a new approach for maintaining a constant soil moisture content below field capacity, by John W. Wolfe, Oregon State College; administration of water resources, by Wayne D. Criddle, State Engineer, State of Utah; plastic film for lining irrigation ditches, by Jack A. Corry and V. H. Scott, University of California; the effect of gravel envelopes on expected yields of wells, by James E. Garton, Oklahoma State University, and the construction and evaluation of the performance of a horizontal well in a shallow thin aquifer, by E. J. Doering, USDA Salinity Laboratory.

A special program for public lands and public works is to be held during the four days of the meeting and through Thursday.

The following information furnished by the local arrangements committee may be helpful in suiting your wardrobe to weather conditions at Santa Barbara during the coming Annual Meeting. The afternoons are not humid and range in temperatures from 70 to 85 degrees. The evening temperatures range from 60 to 70 degrees with possible fog. It is suggested that a business suit be worn in the mornings and that a short sleeve sport shirt might afford the greatest comfort for afternoon wear. A light wrap should be handy for late afternoon and evening wear. It is possible that travelers by automobile will encounter temperatures up to 105 degrees and dry in Nevada and Sunset Valley in California.

Electric Power and Processing Program

Papers to be presented Monday morning will be as follows: "Artificial Light for Controlling the Flowering of Asters and Daisies", by Anthony Kofranek, University of California; "The Application of High Energy Electron Radiation on Various Farm Products," by D. E. Wiant, Michigan State University; "The Effects of Light on the Growth and Feed Efficiency of Broilers," by J. Roberts, State College of Washington; "Time and Travel Studies on Poultry House Mechanization," by B. D. Johnson, Pacific Gas & Electric Co., and "Methods of Minimizing Off-Flavors of Irradiated Foods," by Aaron L. Brody, Whirlpool Corp.

On Monday afternoon there will be discussions on experiences with bulk milk coolers in California, by R. L. Perry, University of California; high capacity push-button silo filling system, by Floyd Herum, University of Illinois; hay pelleting developments, by J. B. Dobie, University of California, and instrumentation for measuring the spectral response of insects, by R. A. Stermer, Texas A. & M. College.

A joint session of the Electric Power and Processing and Farm Structures Divisions will be held Tuesday afternoon with the following papers to be presented: "How to Make a System," by S. S. DeForest, *Successful Farming;* "Feed Handling in California," by R. R. Parks, University of California; "Effect of Moisture on Weight-Volume Relationships of Small Grain," by R. T. Lorenzen, Colorado State University; "Some Mechanical and Rheological Properties of Grains," by G. C. Zoerb, South Dakota State College and C. W. Hall, Michigan State University, and "Controlled Atmosphere Storage for Fruits," by I. J. Pflug, Michigan State University.

The program of the Electric Power and Processing Division will continue Wednesday morning with the following papers: "Fundamental Design Aspects of Electric Heat," by L. N. Roberson, Roberson, Inc.; "Hogmatic Marvel — A System of an Automatic Hog Production," by H. B. Puckett, University of Illinois; "Time and Labor Requirements on a Poultry Farm, Hand vs. Mechanization," by W. E. Matson, Washington State College, and "Development of

Typical of the new buildings on the Santa Barbara Campus is the Music Building *(above)* which incorporates an amphitheater in an inner court area. *(Right)* The Santa Barbara County Courthouse, one of the tourist sights of downtown Santa Barbara, is built to conform with the architectural standards of the Mission padres

the Passion Fruit Centrifuge," by D. M. Kinch, University of Hawaii.

Farm Structures Program

The following topics will be presented on Monday morning: "Hog House Air Conditioning and Ventilation Data," by T. E. Bond, C. F. Kelly, and H. Heitman, Jr., University of California; "Swine Growth and Efficiency in a Naturally Varying Environment," by T. E. Hazen, N. H. Curry, and Henry Giese, Iowa State College; "Ten-Year Summary of Psychroenergetic Laboratory Research," by R. G. Yeck and R. E. Stewart, University of Missouri, and "Relation of Temperature and Relative Humidity to Broiler and Egg Production and Heat and Moisture Output," by H. Ota, ARS, USDA.

Monday afternoon the session on Farm Structures will be continued with discussions on various shade materials, by C. F. Kelly and T. E. Bond, University of California; experimental radiation cooling of dairy cattle, by M. D. Shanklin and R. E. Stewart, University of Missouri; the storage of solar energy, by J. J. McDow and J. S. Boyd, respectively, Louisiana Polytechnic Institute and Michigan State University. A committee report on farm structures research needs and statistics, by Wallace Ashby, ARS, USDA, and a committee report on the Technical Advisory Committee on Plant and Animal Husbandry (joint with American Society of Heating and Air-Conditioning Engineers) will follow.

A joint meeting of the Farm Structures and Electric Power and Processing Divisions will be held Tuesday morning. For further information see Electric Power and Processing program.

The closing session of the Farm Structures Division will be held on Wednesday morning with the following topics: "Farm House Remodeling," by T. J. Brevik, University of Wisconsin; "Design of Safe Stairways," by Joe Miller and M. L. Esmay, Michigan State University; "Graphic Techniques for Farmhouse Remodeling," by K. H. Hinchcliff, University of Illinois; "Building Codes in Agriculture," by E. P. Speck and S. A. Hart, University of California, and "Wind Effects on Open-Front Livestock Shelters," by G. L. Nelson, Oklahoma State University and Henry Giese, Iowa State College.

General Session

J. R. Tavernetti, University of California, chairman, meetings committee, will preside over the General Session to be held on Wednesday afternoon. L. M. K. Boelter, Dean, College of Engineering, University of California, will speak on education for professional engineering, to be followed by the president's annual address, by Earl D. Anderson, director, agricultural extension, Stran-Steel Corp., and presentation of the winning paper in the ASAE student paper award competition.

K. L. Pfundstein, Ethyl Corp., will be the master of ceremonies for the Annual Dinner Wednesday evening and the address entitled "From Where I Stand" will be given by L. J. Fletcher, formerly of Caterpillar Tractor Co. and former president of ASAE.

Special Program for Public Lands and Public Works

This special soil and water program to be held during four days, June 23-26, will include a Monday morning session on progress in land use coordination with papers discussing economic trends of significance to public land managers, by M. L. Upchurch, ARS, USDA; primitive and wild areas in relation to public works, by D. R. Brower, Sierra Club; management and improvement of depleted watersheds, by R. K. Pierson, Bureau of Land Management, USDI, and trends in management and use of federal lands, by J. F. Doyle, Bureau of Land Management, USDI.

Papers for the session on water management and use to be held on Monday afternoon will be on water use considerations in watershed management, by W. T. Murphy, Forest Service, USDA; artificial methods of ground water recharge, by Meyer Kramsky, Calif. Dept. of Water Resources; reclaiming alkali areas, by R. C. Reeve, Salinity Laboratory, USDA; Colorado River storage project, by N. B. Bennett, Jr., Bureau of Reclamation, USDI; status of the saline water program, by J. C. Bradley, Office of the Asst. Secretary for Water and Power, USDI, and irrigation practices in humid areas, by T. H. Quackenbush, SCS, USDA.

During the Tuesday morning session on new developments in erosion and vegetative control there will be a discussion on control of jet blast erosion, by H. C. Cole, first Naval District; use of fertilizers on military grounds, by J. L. Hosterman, third U.S. Army; dust and erosion control of aircraft operating areas in arid and semiarid sections, by C. W. Miller, Randolph Air Force Base; classifications of slopes, by W. D. Ellison, formerly with Bureau of Yards and Docks, U. S. Dept. of the Navy, and control of slides by underdrainage, by A. W. Root, Calif. Div. of Highways.

On Wednesday the second session on new developments in erosion and vegetative control will be held. Following a paper on controlling natural stilling basins, by G. L. Smith, Colo. State University will be a symposium on brush control with H. S. Thompson, U.S. Air Force, as moderator. Discussion will cover power and telephone rights-of-way, by A. F. Wetsch, Bonneville Power Adm., USDI; control of brushlands in California, by N. J. Farrell, Forest Service, USDA; highway rights-of-way, by H. N. Bosworth, Calif. Dept. of Public Works; range lands, by E. L. Flory, bureau of Indian Affairs, USDI, and applying construction equipment in the control of soil erosion and undesirable vegetation, by D. D. Reed, LeTourneau-Westinghouse Co.

A session on recreation and wildlife management as related to public lands and public works, to be held on Thursday morning, will feature management and control of wildlife populations, by L. A. Parker, Bureau of Sport Fisheries and Wildlife, USDI; development of public recreation areas, by R. B. Hatch, Dept. of Natural Resources, Sacramento, Calif.; progress to date in the development of national parks, by Herbert Maier, National Park Service, USDI; recreational facilities of the nation, by G. L. Collins, National Park Service, USDI, and reservoir site clearance as related to recreation and wildlife, by M. C. Huppuch, U.S. Dept. of the Army.

Extension Seminar

An extension seminar with F. W. Andrew, University of Illinois, presiding, will be held Monday morning and will feature a talk on program priorities in agricultural engineering extension in 1959, by J. P. Fairbanks, University of Calif., to be followed by five-minute reports on "Our Most Successful Idea," by J. L. Gattis, Arkansas; B. S. Horne, Pennsylvania; W. L. Ulich,

(Continued on page 312)

R. K. FREVERT

N. A. EVANS

R. W. HANSEN

Richard K. Frevert, professor of agricultural engineering and assistant director of the Iowa Agricultural and Home Economics Experiment Station at Iowa State College, will become director of the University of Arizona Agricultural Experiment Station.

Dr. Frevert is a native of Odebolt, Iowa and holds the B.S., M.S. and Ph.D. degrees from Iowa State College. He joined the staff of the College in 1937 as instructor, and was named assistant director of the experiment station in 1952. At Arizona he will supervise and coordinate research activities in agriculture throughout the state, as well as research in nutrition and household arts done in the school of home economics.

Norman A. Evans was appointed head of the newly created agricultural engineering department within the college of engineering of Colorado State University. The University has had a curriculum in agricultural engineering since 1952. Evans has been in administrative charge since 1954 and chief of the agricultural engineering section in the Colorado Agricultural Experiment Station since 1956. He obtained a B.S. Degree from South Dakota State College in 1944, and an M.S. Degree from Utah State University in 1947. He has been a member of ASAE since 1944.

Ralph W. Hansen, assistant professor in agricultural engineering, Colorado State University, Fort Collins, has been granted a Fulbright Fellowship to be visiting lecturer in agricultural engineering at the University of Helsinki, Finland, for the 1958-59 school year. His duties will include teaching in power and machinery as well as some extension work and advising on organization of courses and laboratories. He will be accompanied by his wife and four-year-old daughter.

Carl A. Johnson, manager of the agricultural and industrial section of Motor Wheel Corp., Lansing, Mich., is retiring from active work as of June 1. He began his association with the farm equipment industry forty years ago when he was assigned to work in Chicago for the Hyatt-Tractor and Implement Division of the Hyatt Roller Bearing Co., designing farm tractors and implements. After 15 years with Hyatt, and when he foresaw the use of rubber tires on tractors and implements, he decided to interest one of the large companies making disc wheels for passenger cars in this new trend, which resulted in his connection with the Motor Wheel Corp. He reports that the first year's business consisted of only 200 wheels, but since that time more than 16 million wheels have been furnished the agricultural industry by his company.

James E. McAlexander has been promoted to sales manager of Delta Irrigation Co., Memphis, Tenn. Starting as a sales engineer in 1954, when the company was organized, he has successively become territory manager and assistant sales manager. In his new position he will be responsible for development and coordination of sales for irrigation and industrial equipment, engines, fans, crop driers and buildings in parts of six states.

C. A. JOHNSON

J. MCALEXANDER

He was graduated from the University of Arkansas in 1954 with a B.S. degree in agricultural engineering and will take an exam for professional registration this fall at the end of a four-year period of engineer-in-training.

Norman C. Teter has been promoted to head the structural requirements and materials section of USDA's Agricultural Engineering Research Division at Beltsville, Md. He replaces Edward G. Mølander who retired after 29 years of government service, most of it with the Department.

Mr. Teter graduated from University of Missouri in 1939 with a B.S. degree in agricultural engineering. He received an M.S. degree from Iowa State College in 1940 in agricultural engineering. Before joining USDA in 1952 he taught agricultural engineering at North Carolina State College. He has spent the past five years working on problems of drying and curing peanuts and small grains at AERD's Tidewater Research Station, Holland, Va.

Delbert M. Byg, extension agricultural engineer and secretary of the Ohio Farm Electrification Council, Ohio State University, has accepted a two-year tour of duty with the Rajasthan College of Agriculture located at Udaipur, Rajasthan, India. He will help to develop a program in agricultural engineering, teaching, extension and research.

Vernon H. Baker took a leave of absence from Virginia Polytechnic Institute during November and December, and opened a new radio station, WESR, "Eastern Shore Radio, The Voice of Accomack and Northampton" in Virginia.

R. M. Peart, professor in agricultural engineering, University of Illinois, has just been awarded a National Science Foundation Scholarship and plans to enter Purdue University in September to continue work on his doctorate.

James J. Hill has become a partner of the Junction City Implement Co. of that city in Oregon. His former position was that of agricultural engineer with Rear's Farm Service.

NECROLOGY

Edgar Vermont Collins, professor of agricultural engineering at Iowa State College, collapsed and died while reading in the periodical room of the College Library, April 2.

E. V. COLLINS

Born at Albion, Iowa, March 12, 1887, he received a B.S. degree in agronomy and a B.S. degree in agricultural engineering from Iowa State in 1914. He joined the college staff as a mechanician during 1914-15 and then was instructor at Kansas State College from 1915 to 1918. He rejoined the Iowa State faculty in 1918. He was a member of Tau Beta Pi, Gamma Sigma Delta and Phi Kappa Phi fraternities and a Fellow of the American Society of Agricultural Engineers, which he joined in 1916.

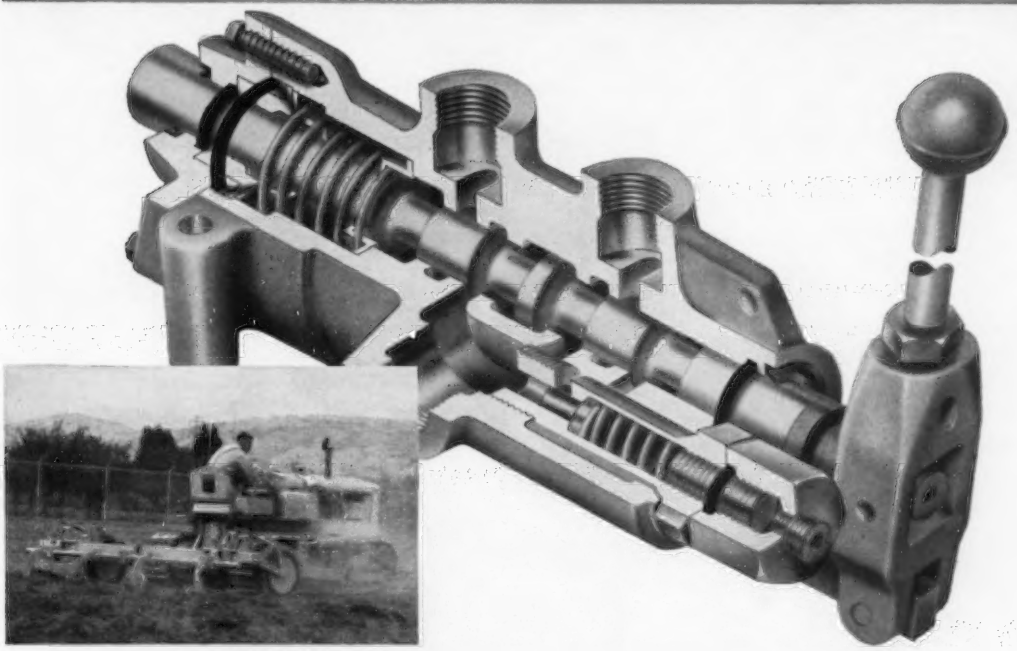
In 1946 he was awarded the John Deere Gold Medal in recognition of his keen interest and adeptness in improving tillage of soil and culture of crops—truly representative of "distinguished achievement in the application of science and art to the soil," for which the award is given.

As an inventor he has been granted many patents, chief of which is the horse-pulling dynamometer used in twenty states, Canada and Germany. His dynamometer work, which included development of several later models, has been credited as a major contribution to the Nebraska tractor testing program and its part in the improvement of farm tractors.

From his tests on the rolling resistance of wheels and tracks came the famous series of wheel tests by Davidson and McKibben. His early use of a hay loader to feed a moving baler in cornstalks offered inspiration for the presently popular pickup balers. During the past few years Mr. Collins has done much work on ridge farming practices and the development of the tandem tractor. A report on the tandem tractor work appeared in the April issue of Agricultural Engineering.

He is survived by his wife, a daughter and two sons.

NATIONAL OIL SEAL LOGBOOK



Use of O-rings as moving seal in heavy duty bulldozer control valve

1,500 psi variation without backup rings. Intermittent operation plus long periods of inactivity. Extreme external dust and dirt conditions. Irregular and unpredictable field servicing. Fluid oil temperatures reaching 180°F. Climatic temperature extremes from —30° to +120°F. Life expectancy is required to be that of the tractor.

Above are the rugged operating conditions faced and met by National industrial O-rings in the new Be-Ge Model SU-1200F bulldozer blade control valve. A total of four rings are employed in each unit; two in a moving shaft application and two as static seals.

Be-Ge reports no leakage or ring failure on hundreds of heavy duty applications involving Oliver, Caterpillar, International Harvester and other crawler tractor installations.

National offers a complete line of industrial O-rings, plus many exclusive compounds. Special compounding is also available to meet unusual conditions.

For complete information on National O-Rings, or for skilled O-ring engineering service, call your nearest National Seal engineer. In major cities nationwide. See the Yellow Pages, under "Oil Seals".

Syntech® Oil Seals

Syntech oil seals, developed by and offered exclusively by National, are widely used synthetic rubber seals for applications where temperatures reach 250°F, speeds reach 3,600 FPM, and total indicator runout is as high as .030. Basic 50,000 series Syntech (illustrated) employs a tough, accurately manufactured steel outer case, precision-tensioned spring and accurately molded and trimmed Syntech sealing lip.

Micro-Torc Oil Seals

Micro-torc oil seals, pioneered by National, are sturdy, dependable leather seals. Special elastomer coating on *surface* of chrome re-tanned leather sealing lip prevents seepage of oil. Yet inner body of sealing lip retains natural porosity to "store" lubricant against accidental periods of starvation. Inherent lubricity of elastomer coating produces a lower torque, longer lasting, economical oil seal. Available in a wide variety of types and sizes.

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

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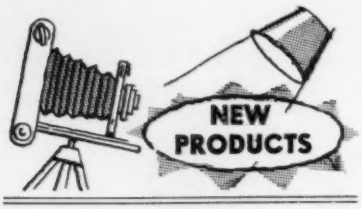


Introduces American-Made Diesels to Tractor Line

Tractor and Implement Division of Ford Motor Co. has introduced a new line of tractors with American-made diesel engines for farm and industrial use. The manufacturer reports that through engineering advancements and manufacturing economies the new line offers a low cost-differential between diesel and gasoline powered tractors. By redesigning some components of the gasoline

4-cylinder tractor engine many of its parts can be used for a diesel engine. All implements in the company's line are said to fit the diesel tractors without modification. The new 4-cylinder diesel engine has a displacement of 172 cu. in. and is rated at 35 hp at the drawbar. It is available in seven models in utility, row crop, and all-purpose types.

(For more facts circle No. 51 on reply card)

Tractor Drives and Steers With All Four Wheels

Napco Industries Inc. has announced that the company would soon market a new four-wheel drive, four-wheel steer tractor. A three-position selector allows the operator to choose front wheel steer, front and rear wheel steer, or oblique steer. Both front and rear wheels turn in the same direction. The manufacturer reports that the tractor

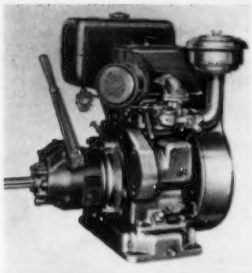
will handle a variety of special attachments such as post hole diggers, backhoes, fork lifts, loaders, plows, subsoilers, and dozers. The transmission is designed to allow the tractor to reverse without stopping or shifting gears. Features include a torque converter, power steering, four speeds forward and four speeds reverse, 360-deg swivel seat, hydraulic brakes, mechanical PTO and an extremely short turning radius.

(For more facts circle No. 52 on reply card)

New 12½-HP Engine

Wisconsin Motor Corp. has announced a new 4-cycle single cylinder air-cooled engine, Model AGN, rated at 12½ hp. The new model has a speed range from 1600 to 3200 rpm and a piston displacement of 38.5 cu in.

According to the manufacturer, the basic high torque of the engine is one of its

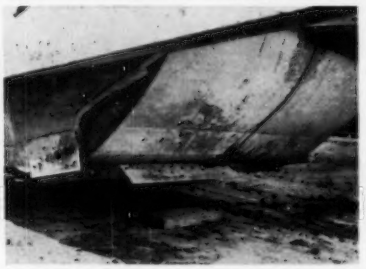


outstanding characteristics. This feature is said to maintain lugging power that resists rpm slowdowns under sudden shock loads, to prevent stalling, and to permit a quick power recovery.

(For more facts circle No. 53 on reply card)

Improved Cutting Edges

Caterpillar Tractor Co. has developed a new hardening process for adding wearability and strength to cutting edges used on

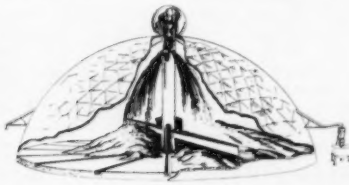


earthmoving machines for tough job conditions. Called "Hi-Electro" hardening, the process is said to produce a super-hard case and to retain a tough shock resistant core.

(For more facts circle No. 54 on reply card)

Stressed Skin Aluminum Domes

Kaiser Aluminum & Chemical Corp. has announced that a factory housed in a stressed skin aluminum dome soon will be built at Abilene, Kansas. The dome structure will be erected for the Fi Fo Conveyor Co., a division of the Vacu-Blast Co., Inc.,



for the manufacture of pneumatic granular conveying systems and to fabricate Kaiser aluminum domes.

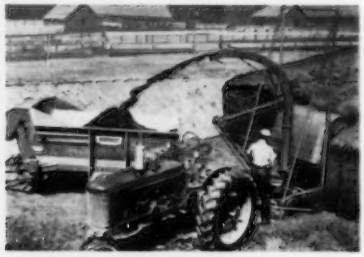
Shown is an artist's cutaway sketch of a proposed grain storage aluminum dome, equipped with Fi Fo conveyors. The 145-ft dome reportedly will hold 400,000 bu.

(For more facts circle No. 55 on reply card)

Trench Silage Loader

The Snow Company has now made available a new silage loader for trench and bunker silos. It is designed to cut the silage loose, pulverize it and blow it into a wagon.

The unit is PTO-driven. With a 5-ft wide cutter drum, the loader takes a bite

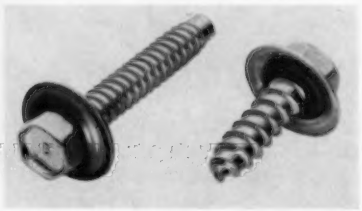


into the silage face 2½ ft deep. It will operate in pits up to 13 ft deep, and when equipped with an optional extension spout, it will deliver at a height up to 25 ft above the floor of the pit. The silage is delivered by means of a blower.

(For more facts circle No. 56 on reply card)

Versatile Seal-Type Fastener

Russell, Burdsall & Ward Bolt and Nut Co. has introduced a new spin-seal fastener designed to provide seal on irregular, corrugated or curved surfaces as well as on flat surfaces. It is available in screw sizes from No. 6 to ½-in. in carbon or stainless steel. The new fastener consists of a spring-type

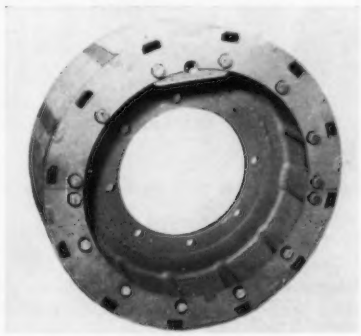


hardened washer with a permanent flowed-in gasket sealant which is preassembled to any type of standard machine screw, cap screw or bolt. The sealant is a polyvinyl chloride base compound which, it is said, can withstand service temperatures from minus 100 F to plus 250 F.

(For more facts circle No. 57 on reply card)

Off-Highway Brakes

B. F. Goodrich Aviation Products has announced a new full-circle brake for off-the-road equipment. The unit is a hydraulic



(Continued on page 304)

This box silo built of pressure-creosoted poles and lumber stands in a feed barn. The cows feed themselves. The only labor—moving the gates and cleaning. The roof and sides are U. S. Steel Galvanized Steel Sheets.

Put up a box silo . . . Put down your pitchfork

Pitchforks and efficiency just don't go together. Every day more and more good farmers recognize this fact and do something about it. Today box silos are appearing on farms all over the country. And for good reasons:

- **Box silos cost less to build.**
- **Box silos are easier to fill.**
- **Dairy and beef cattle feed themselves.**
- **Cut silage feeding time to minutes a day.**
- **The bonus: more free time and no work pitching silage.**

Put up a box silo. The pressure-creosoted wood will keep it up for years. One more point: when ordering your posts and lumber, make certain that they are *pressure*-creosoted *6* to *8* pounds per cubic foot.

Put up a box silo . . . put down your pitchfork.

See your dealer for our booklet, "Horizontal Box Silos," or write to us direct: United States Steel, Room 2831, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

Note: U. S. Steel does not sell pressure-creosoted wood but supplies creosote to the wood-treating industry.

Sales offices in Pittsburgh, New York, Chicago, Salt Lake City and Fairfield, Alabama

USS Creosote
TRADEMARK

(For more facts circle No. 18 on reply card)

Chicago Section

The Chicago Section held a meeting March 3 at the Western Society of Engineers. The program consisted of a discussion of 1000-rpm power take-off as it affects the farm equipment manufacturer, the agricultural engineer and the farmer.

E. W. Tanquary of International Harvester Co. spoke as a representative from industry. He traced the history of the power take-off and discussed factors leading to the development of the 1000-rpm PTO speed. J. A. Weber, agricultural engineering dept., University of Illinois, discussed the subject from the point of view of the technical agricultural engineer by reporting on the economics of a transition from 540-rpm, and Earle Johnson, manager of Clanyard Farms, Huntley, Ill., reported on how he thought the farmer would accept the change.

The Chicago Section will not hold its regular spring meeting, but will meet instead with the Engineers Joint Council, May 19, at the Sherman Hotel in Chicago. The members are urged to take advantage of the excellent program which has been arranged by the Engineers Joint Council and the Western Society of Engineers. The theme of the program is "The Next Decade of Engineering" and speakers will discuss the survey of the engineering profession, education and manpower, applied and basic research, and government in science and engineering. Dr. Walter A. MacNair, vice-president, Bell Telephone Laboratories, will be the speaker for the noon luncheon. His topic will be, "The Development and Design Engineer in the Next Decade."

Iowa Section

The Annual Meeting of the Iowa Section will be held May 16 at Latin King Restaurant in Des Moines, Iowa. Dinner and election of officers will precede the papers to be presented by Mr. John K. King, airways operation specialist, CAA, who will present, "What's Going On Up There?" and Mr. John Hawley, manager, Special Products Department, Goodyear Tire and Rubber Co., whose paper is entitled "The Terra Tire." Mr. Wayne Worthington, director of engineering research, John Deere Waterloo Research and Engineering Center, will present a discussion of Mr. Hawley's paper.

A total of fifty-four members and guests attended the meeting of the Iowa Section of ASAE held on April 4, 1958, at Vic's Tally-Ho Restaurant in Des Moines. E. D. Anderson, director of agriculture extension, Stran-Steel Corp. and president of ASAE, presented a paper on reducing the odds in farming and showed slides of the ASAE headquarters. D. K. Struthers, Tractor and Implement Division, Ford Motor Co., followed his discussion on sales problems with movies entitled "The Things People Want" and "Overcoming Objections."

Michigan Section

The following officers for the Michigan Section were elected for the coming year: Chairman, C. B. Richey, chief research engineer, Tractor and Implement Division, Ford Motor Co.; vice-chairman, W. F. Buchele, associate professor of agricultural engineering, Michigan State University; D. E. Wiant, agricultural engineering department, Michigan State University, and B. G. Elliott, assistant chief engineer, Massey-Harris-Ferguson, Inc.; secretary-treasurer, F. H. Buelow, assistant professor of agricultural engineering, Michigan State University. The nominating committee will consist of D. P. Brown and C. M. Hansen, Michigan State University, and R. J. Alpers, Michigan Vitrified Tile Co.

ASAE MEETINGS CALENDAR

May 16 — IOWA SECTION, Latin King Restaurant, Hubbell and University, Corner of Highway 163 and 6, Des Moines, Ia.

May 19 — CHICAGO SECTION will attend a regional meeting of Engineers Joint Council, sponsored by Western Society of Engineers, Sherman Hotel, Chicago, Ill.

May 22 — MINNESOTA SECTION, Dyckman Hotel, Minneapolis, Minn.

June 22-25 — 51st Annual Meeting, Santa Barbara Campus, University of California, Santa Barbara, Calif.

August 25-27—NORTH ATLANTIC SECTION, Guelph, Ontario, Canada.

October 22-25 — PACIFIC NORTHWEST SECTION, Oregon State College, Corvallis, Ore.

December 17-19 — WINTER MEETING, Palmer House, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Minnesota Section

The Minnesota Section will meet in the afternoon and evening of May 22 at Hotel Dyckman in Minneapolis. Subjects to be presented will include discussions on materials handling, by Sherwood DeForest, associate editor, *Successful Farming;* the influence of electric power on agricultural production buildings, buildings arrangements, and agricultural practices, by Marvin Nabben, Northern States Power Co.; space, time and steel, by A. E. Kvamme, Armco Drainage & Metal Products, Inc.; trends in agricultural practices and farm machinery, by E. A. Silver, New Holland Machine Co.; design implications of the 1000-rpm PTO on Allied equipment, by V. V. Nash, The Farmhand Co., and the new soil and water conservation research station at Morris, Minn., by L. F. Hermsmeir, USDA.

The evening dinner speaker will be Dr. O. B. Jesness, retired head of the department of agricultural economics, University of Minnesota, whose subject will be "What Lies Ahead for the Farmer." J. L. Butt, executive secretary of the ASAE, will represent ASAE headquarters.

Rocky Mountain Section

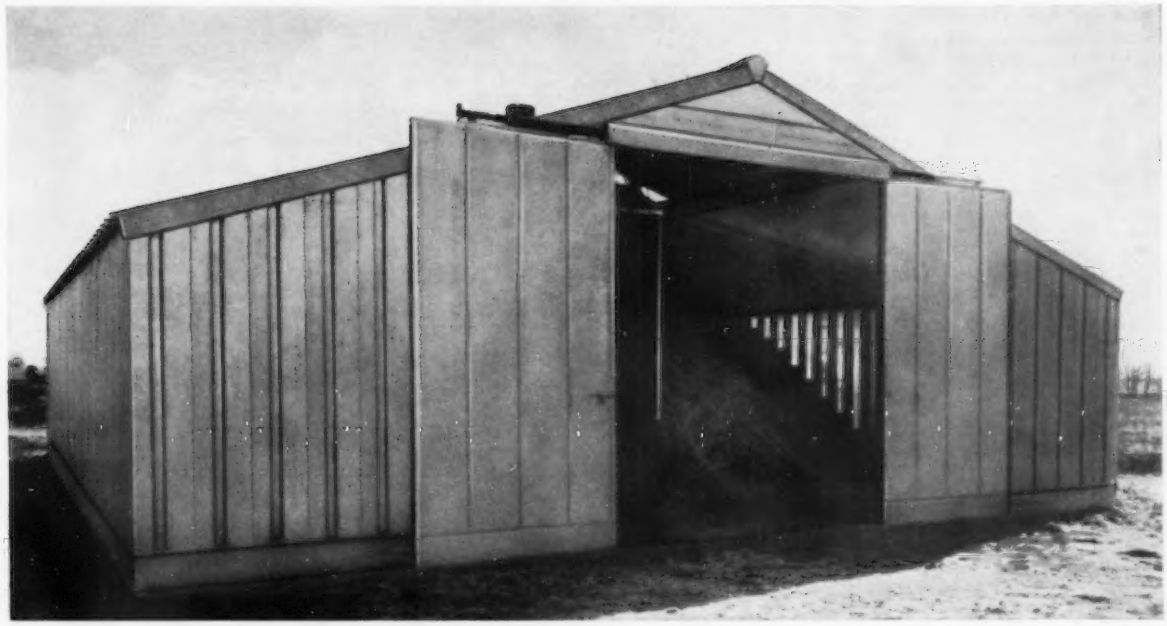
The Rocky Mountain Section Meeting was held March 28-29 on the campus of Colorado State University, Fort Collins. The new Section officers elected are: Chairman, Cleve H. Milligan, Utah State University; Vice-Chairman, A. S. Curry, associate director, New Mexico A. & M., and Secretary-Treasurer, Glen Stringham, Utah State University. The 1959 Section meeting will be held at Logan, Utah.

The program proved to be outstanding with the entire region represented. Mem-

(Continued on page 312)

On hand for the Rocky Mountain Section meeting were *(left to right)* Glen E. Stringham, secretary-treasurer; N. A. Evans, retiring chairman; J. L. Butt, executive secretary of ASAE; C. H. Milligan, chairman; J. W. Borden, vice-president-elect of ASAE; and T. H. Evans, dean, engineering college, Colorado State University.

(Right) ASAE President E. D. Anderson and D. K. Struthers, Tractor and Implement Division, Ford Motor Co., were speakers during the April 4 meeting of the Iowa Section. *(Left to right)* President Anderson; L. F. Janssen, Section chairman; and Mr. Struthers



After grain is removed from this 36′ x 48′ Armco Grain Storage Building near New Hope, Ohio, it is ideal for other farm jobs.

How Armco Farm Buildings

Assure Weathertight, Trouble-Free Grain Storage

Armco Grain Storage Buildings take the guesswork out of crop storage. Specially designed STEELOX® Panel walls, for example, meet your requirements without lining or bracing. Grain is piled high, directly against the sidewalls, with no danger of cracking or giving way under pressure.

Fabricated from extra-durable, 20-gage Armco ZINCGRIP® Steel, the 16-inch-wide panels provide structural support and exterior covering in a single unit. Tight interlocking construction protects against weather, rodents and insects.

Maintenance costs are practically eliminated. All-steel parts leave nothing to rot or warp. And steel is noncombustible.

Armco Grain Storage Building capacities range from 3,820 bushels up. Write us today for data. No obligations. Armco Drainage & Metal Products, Inc., 5188 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.

A 40′ x 80′ Armco Building at Joplin, Montana, stores 29,000 bushels of durum wheat. Note simple buikhead at doorway.

ARMCO®

ARMCO STEEL BUILDINGS

(For more facts circle No. 2 on reply card)

. . . New Products

(Continued from page 300)

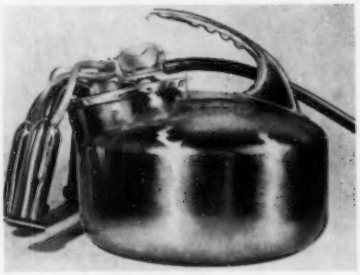
drum type brake with 360-deg expander tube actuation designed exclusively for large tractors, scrapers and earthmovers.

The new brake is said to operate with nearly constant lining pressures at all points around the drum area, at one-half the usual maximum lining pressure. Made in most popular sizes, the brake is bolted as a single unit to the axle or axle housing of the vehicle and uses either air or hydraulic power.

(For more facts circle No. 58 on reply card)

Improved Milker

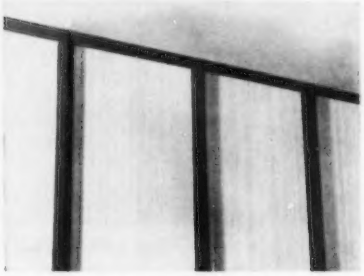
Babson Bros. Co. has announced improvements in its new Surge bucket milker for 1958. A shiny, smooth interior surface matching the exterior has been added. The new feature makes it difficult for material of any kind (especially milkstone) to accumulate and makes it easier to wash and keep clean. The mouth of the new unit is tilted at an angle to conform with the forward slope of most cow's udders. This feature is said to provide more effective milking action to each quarter. The new unit reportedly is well-suited for hard-to-milk cows, especially those with uneven udders and those slow to let down their milk.



(For more facts circle No. 59 on reply card)

New Building Panels

Masonite Corp., has developed new linear-textured hardboard panels and shaped wood battens spaced at regular intervals for providing an unusual and interesting exterior appearance in a residential or commercial structure.

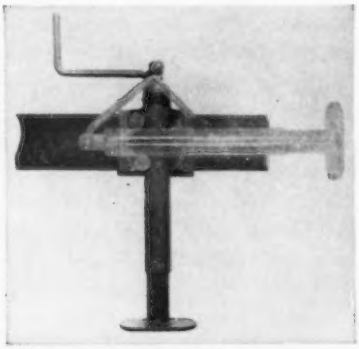


The combination includes ridgeline siding and battens. Geometrically, the batten is a trapezoid having a base 1¼ in. wide, two tapered edges of 15/16 in. leading to the top which is 5/16 in. wide. For panel and batten construction, ridgeline is available in lengths ranging from 3 to 16 ft. It is ¼ in. thick.

(For more facts circle No. 60 on reply card)

Implement Jack

Hammer Blow Tool Co. has announced a new front end lifting jack especially designed for agricultural implements which have drawbars close to the ground and where the power take-off interferes with the standard type of lifting jack. This new jack can move from a vertical position to a horizontal position by merely pulling the locating pin which is spring loaded and by turning the entire assembly 90 deg to horizontal or vertical position, whichever the case may be. Available in two types, one has a gear and rack movement with a side mounted crank, the other has a screw type movement using top mounted crank.



(For more facts circle No. 61 on reply card)

WHO specifies WISCONSIN heavy-duty Air-Cooled ENGINES?

A Good Question . . .

and here's the answer

IT'S the seasoned "professionals" . . . qualified men like yourself, who *know engines* and the operating demands they must meet in rugged field service, who specify "Wisconsin Power" . . .

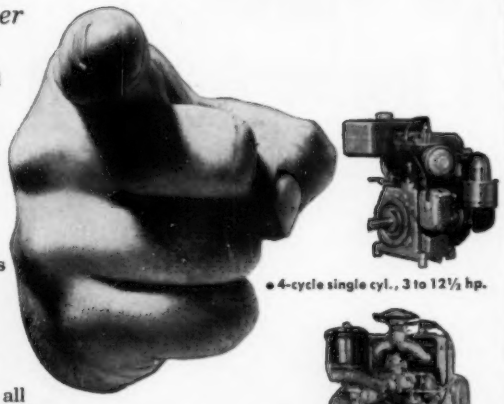
Men like *you,* who have had the opportunity to compare and weigh performance characteristics of engines on your own equipment, under your conditions;

Men like *you,* who appreciate the advantages of Wisconsin heavy-duty design and construction in all details . . . in terms of operating dependability; low-cost maintenance and long engine life;

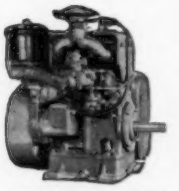
Men like *you,* who know the value of Wisconsin High Torque engineering and performance . . . to give you the load-holding *Lugging Power* that hangs on through the shock-load pinches without stalling;

Men like *you,* who have learned from experience that there is no substitute for Wisconsin trouble-free AIR-COOLING . . . efficient at all temperatures from sub-zero to 140° F.

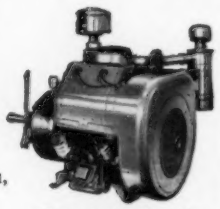
Full scale *specialization* in the manufacture of heavy-duty air-cooled engines and a full line of 4-cycle single cylinder, 2- and V-type 4-cylinder models from 3 to 56 hp. (all models can be equipped with convenient, quick-action ELECTRIC STARTING) are additional reasons why *power professionals,* like you, specify "WISCONSIN." Write for engine bulletin S-223 for a briefing on the full line.



• 4-cycle single cyl., 3 to 12½ hp.



• 2-cylinder, 10 to 18 hp.



• V-type 4-cyl., 15 to 56 hp.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

(For more facts circle No. 24 on reply card)

Design SAFETY into your Drive Lines.

NEAPCO
Shielded Drive Assembly

NEW DESIGN FEATURES

WIDER APPLICATIONS

- **Easy disassembly for cleaning, greasing, maintenance.**
- **Available in light and heavy duty series.**
  (1500–1600 Light Duty Series, 1800 Heavy Duty Series.)
- **Designed and manufactured to your specifications.**
- **Provides maximum performance and safety protection.**

Your best source for a complete range of P.T.O. requirements.

SINGLE JOINTS

STANDARD LENGTH

SHORT LENGTH

SLIP LENGTH

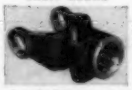
END YOKES—complete range of bore sizes.

Standard Round

Short Round

Square

Slip Length


Quick Disconnect

Clamp Type

Drive Assemblies to your specifications.
Single Joints and End Yokes in a complete range of sizes.

Neapco is a well known source, with over 35 years of engineering and manufacturing experience . . . able to fill most any drive line and universal joint design requirement you have. Neapco P.T.O. Drives are rugged, precision built for all types of duty. They are supplied with plain or needle bearing journal crosses in a wide variety of yoke combinations. Used as standard equipment for many leading manufacturers in the Agricultural and Truck field.

Send us your specifications, or write for free engineering literature.

NEAPCO PRODUCTS INC.,
POTTSTOWN, PA.

NEAPCO

(For more facts circle No. 3 on reply card)

120,000 of these detonator plugs

equal

one 73 lb. bumper strip

both are products of

ORCO CUSTOMEERING

The precision pigmy component weighs less than $\frac{3}{10}$ of a gram and is an important part of a delicate detonator assembly. The 73-lb. bumper strip is a protective part of a "Dodgem" car in amusement parks.

Big difference in size and application? Sure, but Ohio Rubber is recognized as a producer of "customeered" parts made from rubber, synthetic rubber, silicone rubber, polyurethane, and flexible vinyl, in *all sizes*, for any application, and whether molded, extruded, or bonded to metal.

From design through electronically controlled compound mixing and production facilities in four plants, Ohio Rubber's integrated set-up is prepared to handle your most exacting rubber and vinyl component requirements. Let ORCO engineers help on your next problem. See how ORCO CUSTOMEERING can work to your greater advantage.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts."

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Willoughby, Ohio

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(*NOTE: A subscription to AGRICULTURAL ENGINEERING is included in the annual dues of each ASAE member.)

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☐ I want to receive AGRICULTURAL ENGINEERING regularly. Enter my subscription for one year ($5.00 in USA; $5.50 in Canada; $6.00 elsewhere). Payment is enclosed.

☐ I would like information about membership in the American Society of Agricultural Engineers, including an application form. (I understand that a subscription to AGRICULTURAL ENGINEERING and a copy of AGRICULTURAL ENGINEERS YEARBOOK are included in the annual dues of ASAE members.)

☐ I am an ASAE member and suggest that membership information, including application form, be sent to the name and address below. I can supply names of _____ more prospective members. My name is _____

Name _____

Position or title _____

Address (☐ Home or ☐ Business) _____

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Do you want more data or other information on products or catalogs advertised or otherwise featured in this issue? Then fill out one of the two mailing cards at the right and drop it in the mail today.

Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

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2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
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5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
10	20	30	40	50	60	70	80	90	100

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Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

Up to 40% MORE CAPACITY for your money!

NEW

McCORMICK® No. 36 FIELD HARVESTER

Now, chop a 5-ton wagon load in 8½ minutes! Direct-cut up to 35 tons of hay in a single hour! Slash your forage costs with a new McCormick No. 36 field harvester that chops as much as 40 per cent more than other choppers in its price class.

This tonnage-boosting capacity begins with the all-new cutter bar which handles any crop—heavy, tall, or tangled! New cam-action reel, with spring-steel teeth, sweeps a full 6-foot swath into the full-width positive auger feed. Retracting fingers on the auger carry cut crop from reel teeth to self-adjusting feed aprons.

Floating upper feed apron rides the crop to positively feed a full swath in any condition—compresses and grips crop for clean cutting to any length from ¼ to 6 inches. Heavy 6-bladed, 44-inch-diameter cutter head makes 4,500 cuts a minute . . . develops tremendous slice-through momentum—helps you chop record tonnage with less power, at lowest cost.

3 INTERCHANGEABLE HEADS . . .
All-new Cutter Bar
Windrow Pickup
Big-capacity Row Crop
—with fast 4-bolt mounting

In a single hour, the McCormick No. 36 chops enough forage to fill this new 5-ton McCormick No. 60 power unloading wagon seven times!

Your IH dealer would enjoy swapping information with you on modern forage handling techniques and machinery. Stop in today and get complete information on the No. 36 Field Harvester.

See Your INTERNATIONAL HARVESTER Dealer

International Harvester Products *pay for themselves in use*—Farm Tractors and Equipment . . . Twine . . . Commercial Wheel Tractors . . . Motor Trucks . . . Construction Equipment—General Office, Chicago 1, Illinois

(For more facts circle No. 5 on reply card)

MANUFACTURERS' LITERATURE

Pulley Lagging

Condersite Engineering Corp. — This 4-page folder illustrates and describes the use of a fabric of woven asbestos for pulley lagging. It describes the product, its uses, and methods of application.

(For more facts circle No. 62 on reply card)

Self-Priming Liquid Ring Pump

Goulds Pumps, Inc. — Bulletin 725.6 describes a new self-priming liquid ring pump for transfer air, liquid or combinations of air and liquid. Specifications, performance curves and construction data are included.

(For more facts circle No. 63 on reply card)

LP-Gas

National LP-Gas Council — A 23-page booklet, "Modern Fuel for Millions," on the advantages of LP-Gas for the home and farm. Included are illustrated sections on heating, cooking, hot water, refrigeration, clothes drying, garbage disposal, better farming, tractor power, etc.

(For more facts circle No. 64 on reply card)

Pole-Type Farm Building Plans

Aluminum Co. of America—A 21-page catalog contains plans for pole-type construction with the use of aluminum roofing and siding. Complete plans are shown for a general purpose barn, machinery center, southern poultry house, loafing barn, 30-cow pen stable, northern poultry house, warehouse, 70-cow pen stable barn, and general purpose shelter.

(For more facts circle No. 65 on reply card)

Limit Switches

Micro Switch—This 4-page data sheet, No. 138, describes the line of small-size, 2-circuit, limit switches. Photographs, dimensional and line drawings, characteristics, electrical ratings and price information are included in this sheet.

(For more facts circle No. 66 on reply card)

Power Feeding System

American Planter Co. — An 8-page brochure describes the new Model 1400B automatic feeding system. The parts that make up the system are said to fit most any installation where feed or grain need be moved or to pick up feed at any place delivering and distributing where desired.

(For more facts circle No. 67 on reply card)

Farm Equipment

Allis-Chalmers Mfg. Co.—The following literature describing recent developments in farm equipment has been released:

A 16-page catalog, BU-413, describes two new diesel engines, Models D-344 and D-516. Photographs, cutaways, charts and other illustrations explain the operating and performance features of the two engines.

(For more facts circle No. 68 on reply card)

A 12-page catalog, TL-1855, entitled, New Power for Your Growing Future, contains pictures describing the new 1958 line of farm equipment.

(For more facts circle No. 69 on reply card)

An 8-page catalog, BU-415, features a line of the company's irrigation engines. Views and cutaways of the various power units; pictures of important engine components, engine horsepower graphs, photographs of the units in action, and specifications are illustrated.

(For more facts circle No. 70 on reply card)

Tool Bar Attachments

Caterpillar Tractor Co. — An 8-page bulletin 32863 describing and illustrating tool bars, attachments, and a variety of specialized implements for the company's line of track-type tractors.

(For more facts circle No. 71 on reply card)

Magnetic Drives

Whitney Chain Co. — An 8-page bulletin W-T 2-57 features a magnetic drive described as a "safety go-between" that is installed between motor and machine, designed to protect all kinds of equipment from the dangers of sudden starts and stops as well as overloads.

(For more facts circle No. 72 on reply card)

Boralloy Sprockets

Caterpillar Tractor Co.—An 8-page booklet, DE739, contains photographs, drawings, and cutaways describing the manufacture of Boralloy sprockets which are said to wear up to twice as long. The booklet describes the role boron plays in creating depth of hardness.

(For more facts circle No. 73 on reply card)

Horizontal Box Silo Plans

United States Steel Corp. — A 16-page booklet contains plans for selection of the correct size and step-by-step instructions for the construction of horizontal box silos.

(For more facts circle No. 74 on reply card)

Galvanized Steel Sheets

American Iron and Steel Institute—A 16-page brochure describes the use of galvanized steel sheets for roofing and siding from a standpoint of economy, strength and fire protection.

(For more facts circle No. 75 on reply card)

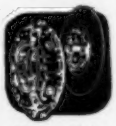
ROCKFORD

RM CLUTCHES

Provide a Wide Range of Driven Member Assemblies

ROCKFORD R-M CLUTCH driven member assemblies can be furnished in several different types—to meet the specific operation needs of the machines in which they are to be used. A cushion type plate is available, as well as the plain type. Facings can be had for dry operation, or in oil. All plates can be furnished with or without the dampener feature. May be arranged with flat cover for use with counterbored flywheel or with cupped cover for use with flat flywheel. Let ROCKFORD CLUTCH engineers help you specify the clutch that meets your particular needs exactly.

Small Spring Loaded


Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Speed Reducers

BW **SEND FOR THIS HANDY BULLETIN** Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER

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CLUTCHES

(For more facts circle No. 25 on reply card)

The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

Planned Irrigation Pays, by N. H. Wooding, Jr. Special Circular 33. The Pennsylvania State University, College of Agriculture, Extension Service, University Park, Pennsylvania.

Constant Flow Equipment for Field Application of Non-Pressure Liquid Fertilizers and Soil Fumigants, by J. G. Futral, J. L. Butler, J. H. Ford and E. F. Savage. Mimeograph Series N. S. 35, April 1957. Georgia Agricultural Experiment Station, University of Georgia, Athens, Ga.

Planning the Machinery Storage and Shop Structure, prepared by G. E. Henderson and C. E. Turner, June 1957. Copies are available from Coordinator's Office, Southern Assn. Agr. Eng. and Vocational Agriculture, Barrow Hall, Athens, Ga. Price 70 cents per copy.

Precision Metering Device for Fertilizers and Other Materials Used in Field Plot Work, by J. G. Futral, J. T. Reid and J. L. Butler. Mimeograph Series N. S. 34, March 1957. Georgia Agricultural Experiment Station, University of Georgia, Athens, Ga.

Handling Cotton Planting-Seed at Cotton Gins, by G. N. Franks and J. C. Oglesbee, Jr. Production Research Report No. 7, April 1957, USDA. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 10 cents.

The 1957 Grassland Proceedings, annual program of the Joint Committee on Grassland Farming held at Stanford University in Palo Alto, Calif., on August 29, 1957. For further information write to Z. W. Craine, Secretary-Treasurer, American Grassland Council, P.O. Box 30, Norwich, N. Y.

Nailed Trussed Rafters for Industrial and Farm Structures, by E. George Stern. Bulletin No. 33, February 1958. Virginia Polytechnic Institute, Wood Research Laboratory, Blacksburg, Va.

Farm Electrification Catalog of Visual Aids, Publication No. 57-17, price 50 cents. Commercial Department, Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y.

A Crop Harvester for Forage Plots, by J. G. Kemp and W. Kalbfleisch. Reprinted from Canadian Journal of Plant Science 37:418-422, October 1957. Canada Department of Agriculture, Ottawa, Ontario, Can.

A Vibrator-Powered Meter for Small Grain and Ground Feed, Bulletin No. 611, June 1957, and *Volumetric Feed Meters,* Bulletin No. 618, September 1957, by H. B. Puckett and Robert M. Peart; *Electronic Controller for an Automatic Feed Grinder,* Bulletin 615, August 1957, by H. B. Puckett. Agricultural Experiment Station, University of Illinois, Urbana.

Buying Your Sprinkler Irrigation System, by Ben A. Jones, Jr. Circular 789, January 1958, University of Illinois College of Agriculture, Urbana, Ill.

ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by C. HOTCHKISS, JR.

Application Engineer,

Stow Manufacturing Company

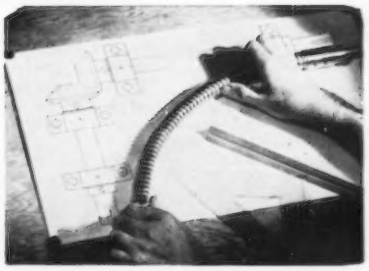
Flexible shafting has the following advantages over other type drives:

1—It is often the simplest method of transmitting power between two points which are not collinear or which have relative motion

2—eliminates exposed revolving parts

3—does not require accurate alignment

4—easy to install and maintain.



RELATIVE MOTION—Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾-inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Co.

NOT COLLINEAR—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼-inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

Fig. 1

Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅛ inch to 1¼ inches; for remote control applications in diameter sizes from ⅛ inch to 1⅝ inches.

The 1¼ inch power drive shaft will transmit up to 10 HP while the 1⅝ inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering bulletin 570.

STOW MANUFACTURING COMPANY

39 SHEAR STREET • BINGHAMTON, NEW YORK

(For more facts circle No. 19 on reply card)

. . . Meeting Program

(Continued from page 297)

Texas; H. E. Wichers, Washington; and M. A. McNamee, Wyoming. An open forum with S. P. Lyle, Federal Extension Service, as leader will be held for discussing reports plus comments from other states. H. S. Pringle, W. T. Welchert, and D. C. Larsen will speak on extension cooperation with interstate and USDA, with other subject matter groups, and industry, respectively. R. O. Gilden will present a summary of the session.

Student Program

A student Program to be held Monday morning with Kermit Allard, University of Maine, president, national council of ASAE student branches, presiding will begin with a Welcome to California, by Roy Bainer and a talk "Your Student Branch Committee," by A. M. Best, New Holland Machine Co., chairman, ASAE Committee on Student Branches. Roll call of student branches, by Glenn Drummond, Alabama Polytechnic Institute, secretary, national council of ASAE student branches; presentation of winning papers in the ASAE student paper award competition, and an address by Earl D. Anderson, ASAE president, will be included in the program.

Monday evening there will be an FEI complimentary Student Dinner for student representatives and faculty advisers of ASAE Student Branches at the Carillo Hotel, courtesy of Farm Equipment Institute.

John Williams, Pennsylvania State University, 1st vice-president, national council ASAE student branches, will preside over the Tuesday morning session which is to feature a talk on ethics in engineering by C. T. Rasmussen, John Deere Killefer Co. and an annual report from ASAE headquarters on student branch affairs, by J. L. Butt, executive secretary, ASAE, to be followed by a discussion on developing stronger student branches. Nominations of 1958-59 officers, national council of ASAE student branches, will conclude the morning session.

E. C. Musser, Allis-Chalmers Mfg. Co., chairman, ASAE Committee on FEI Trophies will give a review of the 1958 FEI trophies competition in the Wednesday morning session. Election of officers for 1958-59, national council of ASAE student branches will follow.

. . . News

(Continued from page 295)

Plans Open Days Program

The National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England, will be open to the public on July 9 and 10. Exhibits will include projects under research and development and those being tested. Visitors will see hydrostatic transmissions, wheel motors, wheel research and steering mechanisms for tractors in the research and development stages. Over 50 research and development projects will be on display.

Testing projects will include batch grain driers, hop drying installations, fertilizer distributors, water pumps, and vegetable washing machines. Under tractor testing are British Standard tests, NIAE tests, farm trials, dust chamber, hot chamber and hydrostatic transmission components.

. . . Section News

(Continued from page 302)

bers were present from New Mexico, Utah and Wyoming as well as Colorado, making a total of 130 in attendance.

Five well prepared papers were presented for the student paper contest. The winner for the first place was Henry Mayland, Wyoming University; second place, Charles Huntley, Colorado State University; third place, Gerry Costel, Wyoming University.

The 130 who attended the annual dinner included the governing board of the University, the president and the academic deans. The highlight was an address by Dean Ivan C. Crawford, director of the Colorado Water Conservation Board on the status of Upper Colorado River Development.

In addition to presentations by Section members, speakers from other areas included C. J. Frances, Soil Conservation Service, Washington, D.C., who presented a paper on engineering in the soil conservation service; M. L. Burgener, Portland Cement Association, Chicago, who spoke on farm buildings with concrete; Fred H. Buelow, Michigan State University, assisted Clarence F. Becker in a discussion on solar energy for farm use; C. E. Staff, Bakelite Corp., New York, presented a paper on new uses for plastics in agriculture; C. B. Richey, Tractor and Implement Division, Ford Motor Company, Birmingham, Mich., discussed free-piston turbine power for farm tractors, and R. R. Poynor, International Harvester Co., Chicago, presented a paper on trends in farm practices. J. L. Butt, executive secretary of ASAE, represented national headquarters.

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with choice of over four hundred interchangeable orifice tips. Every type of spray pattern. Write for Catalog 30.

TEEVALVE
selector valve for booms with spray selection in shut-off position. Write for Bulletin 84.

GUNJET SPRAY GUNS
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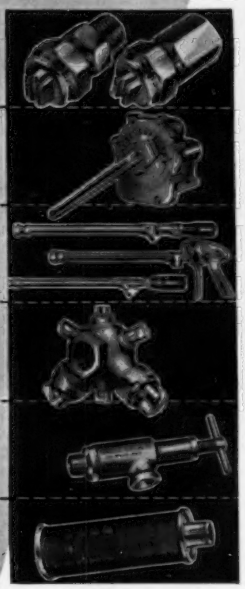
BOOMJET SPRAY NOZZLES
spray up to 66 feet wide for broadcast spraying with one nozzle. Bulletins 66 and 71.

PRESSURE RELIEF VALVES
dual spring assembly for low and high pressures . . . write for Bulletin 83.

SUCTION STRAINERS
withdraw liquid within 1" of drum bottom. Write for Bulletin 85.



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(For more facts circle No. 21 on reply card)

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Anner, Henry, Jr.—Sales engr., Moore Dry Kiln Co. (Mail) 4895 Riverdale Rd., Jacksonville 10, Fla.

Berg, Paul O.—Consulting engr., 406 Transfer Bldg., Fort Wayne 2, Ind.

Berberoglu, Hayri — Graduate student, agr. eng. dept., Univ. of Tennessee, Knoxville, Tenn.

Cogar, Glover R., Jr. — Eng. exec. asst., Atlas Scraper & Engineering Co. (Mail) 3377 Seminole St., South Gate, Calif.

Day, Bobbie G.—Area engr. (SCS) USDA (Mail) 1208 Santa Fe, Clinton, Okla.

Dunlap, H. Craig—Sales engr., Ohio Machinery Co. (Mail) R.R. 1, Lexington, Ohio

Good, John R. — Irrigation and agr. rep., Idaho Power Co. (Mail) 448 Highland Drive, Payette, Ida.

Henry, Zachary A. — Graduate student, agr. eng. dept., Clemson Agr. College, Clemson, S. C.

Huhner, Merle L. — Soil conservationist (SCS) USDA (Mail) 902 McHugh Ave., Grafton, N. D.

Johnstone, Hugh G. — Resident engr. for France, J. I. Case Co. (Mail) 54 Longford Ave., Southall, Middlesex. England

Keppeler, Richard A.—Instr., res., agr. eng. dept., Michigan State Univ., East Lansing, Mich.

Klapproth, Edward H. — Layout and des., Flexible Co. (Mail) R.R. 4, Mt. Zion Rd., Mansfield, Ohio

LaRoe, Clarence C. — Partner, LaRoe's Shop, Star Route, Eustis, Fla.

Layton, Robert — Area engr. (SCS) USDA (Mail) R.R. 4, Wapakoneta, Ohio

Mandal, Ranajit K. — Asst. engr., Trepina Admn., Indian Government (Mail) 10 M. N. GanGuly Rd., Tala, Calcutta 2, India

Maness, Charles B.—Sales engr., Aeroglide Corp. (Mail) R.R. 4, Raleigh, N. C.

Manor, Gideon—Dir., agr. and machy. div., Ministry of Agriculture, Hakirya, Tel Aviv, Israel

Merrill, Richard E.—Zone mgr., New Departure Div., General Motors Corp., 3108 23rd Ave., Moline, Ill.

Mulliner, H. Robert—District ext. irrigationist, Univ. of Nebraska (Mail) P.O. Box 416, Hastings, Nebr.

Pedersen, Thomas T.—Grad. student, agr. eng. dept., Michigan State Univ., East Lansing, Mich.

Quant, Angel—Head, finance dept., Government of Nicaragua (Mail) Apartado 14-04, Managua, Nicaragua

Schicht, Richard J. — Asst. engr., Illinois State Water Survey (Mail) 433 Fairlawn Drive, Urbana, Ill.

Schmidt, James W. — Sales rep., Louisiana Power & Light Co. (Mail) Kentwood, La.

Seals, Thomas A. — Salesman, R. C. Cropper Co. (Mail) 1135 Western Way, Orlando, Fla.

Stone, Richard H.—State conservation engr. (SCS) USDA, 10 Mill St., Orono, Me.

Towse, Edward A. — Owner, Towse Ranch, Creston, Calif.

Walker, Thomas O.—District farm fieldman, Portland Cement Assn. (Mail) 916 Falls Bldg., Memphis, Tenn.

Transfer of Membership

Mason, John P. H., Jr. — Asst. prof., agr. eng. dept., Virginia Polytechnic Institute (Mail) McBryde Village, Blacksburg, Va. (Associate Member to Member)

Parady, William H. — District supervisor, Florida Ford Tractor Co., P.O. Box 1258, Jacksonville, Fla. (Associate Member to Member)

Powell, Charles D. — Mgr., eng. section, Doane Agricultural Service, Inc. (Mail) 1035 N. Harrison, Kirkwood 22, Mo. (Associate Member to Member)

Student Transfers

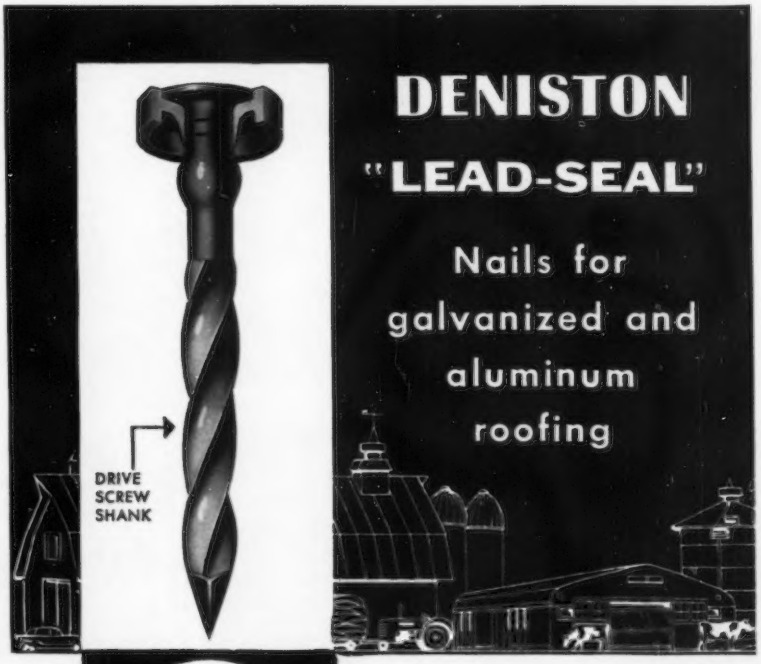
Bass, Arthur S. — Student, Purdue Univ. (Mail) Tuscola, Ill.

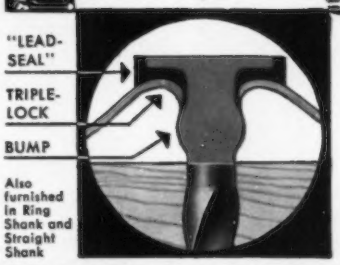
Carlton, James B. — Student, Univ. of Georgia (Mail) Apt. 21, Univ. Court Apts., Athens, Ga.

Drummond, Glenn—Student, Alabama Polytechnic Institute (Mail) Auburn Hall, Auburn, Ala.

Hamilton, Orian L.—Student, Purdue Univ. (Mail) 500 W. Stadium Ave., West Lafayette, Ind.

(Continued on page 316)





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Descriptive literature on Deniston "Lead-Seal" nails will be sent immediately upon request.

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DENISTON Lead-head ROOFING NAILS

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PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin, the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICUTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listing.

POSITIONS OPEN—1957—NOVEMBER—O-360-758, 380-762. DECEMBER—O-385-763, 386-764, 387-765, 412-766, 370-767. 1958—JANUARY—O-478-769. FEBRUARY — O-12-801, 48-803. MARCH — O-37-804, 72-805, 78-806, 83-807. APRIL—O-70-808, 97-809, 122-811, 121-812, 120-813.

POSITIONS WANTED — 1957 — NOVEMBER — W-337-43, 320-44, 344-45, 356-47, 357-48, 342-49, 291-50, 363-51. DECEMBER—W-371-52, 378-53, 394-54, 405-55, 409-56, 415-57. 1958 — JANUARY—W-447-58, 410-59, 381-60, 466-61, 484-62, 485-63, 3-1, 4-2. FEBRUARY — W-21-4, 31-5, 33-6. MARCH—W-36-8, 62-9, 46-10, 74-11, 80-12. APRIL—W-47-13, 77-14, 98-15, 102-16, 107-17, 94-18, 106-19.

NEW POSITIONS OPEN

ENGINEER to take complete charge of all phases of engineering for specialized farm equipment manufacturer in Midwest. Prefer man under 32 with at least one year of experience with a farm equipment manufacturer. Opportunity for advancement to stockholder and officer. Twelve-year old company with increasing sales. Financially sound. Top management under 40 years of age. Salary open. O-129-814

AGRICULTURAL ENGINEER for extension work in power and machinery field, with some electric power and processing applications in a southwestern state. BSAE. MS preferred. Farm background and professional experience in power and machinery field. Liking and ability for work with associates and farm people. Opportunity normal for extension work. Open to be filled July 1. Salary open, $7500 or more to start. O-147-815

AGRICULTURAL FIELD PROMOTION REPRESENTATIVES (2) for education, development, promotion, and technical service work with national trade association in building materials field. Work involves personal calls on agricultural colleges, extension services, government agencies, lumber dealers, farm building fabricators and contractors, equipment manufacturers, feed and milling companies, farm cooperatives, and farm groups. East and Midwest territories. BSAE, preferably with major in farm structures. Must be professionally competent. Age 28-40. Practical experience in agricultural engineering with emphasis on farm structures or near-related field. Genuine interest in farm structures and liking for personal contact work. Mature approach to solution of problems. Willing to do reasonable amount of travel. Excellent opportunity for qualified men willing to work. Salary open. O-131-816

RESEARCH ASSISTANTS (3) for half-time on department research and half-time on graduate study in agricultural engineering in an eastern state university. BSAE or equivalent. No experience required. Desire to do research. Ability to get along and work with others. Graduate school tuition waived. Social Security and teachers retirement. Salary $1800 for 12 months, with one month vacation. O-69-817

AGRICULTURAL ENGINEER, assistant or associate professor, for research in farm electrification and processing in an eastern state school. Possible opportunity for limited amount of teaching in this field. BSAE or BSEE minimum. MSAE, MSEE, MSME or MS in physics desirable. Phd in Physics or engineering given special consideration. Age 25-40. Two years or more in research or development. Ability to work with others. Initiative, aggressiveness, potential for leadership and advancement. Key staff position with ample opportunity for professional growth, program expansion, and advancement. Regular increases, annual and sick leave, and retirement benefits. Group life and hospitalization insurance available. Salary $6240-6900 to start. O-132-818

COORDINATOR for eastern state farm and home electrification council. Responsible for planning and organizing in-service training programs for professional agricultural workers and coordinating well established program in farm and home electrification. BSAE. Age 25-45. Minimum of two years as extension specialist or agricultural engineer with power supplier or equipment industry. Able to work with others, plan and direct work of committees. Excellent opportunity for professional growth and advancement in grade and salary. Outstanding statewide program in operation 12 years. Salary $6000-6900 to start. O-132-819

AGRICULTURAL ENGINEER (instructor) for research and teaching in food processing at an eastern state university. BSAE or BSChE, MS desirable; or BS in food technology or dairy technology with MS in engineering. Age 21-35. Some experience in food process engineering desirable but not essential. Initiative, imagination, and ability to cooperate. Excellent opportunity for development and advancement with a rapidly growing program. Position to be filled as soon as possible. O-154-820

AGRICULTURAL ENGINEER for product planning analysis with established farm equipment manufacturer in Midwest. Work primarily on bulk materials handling, grain processing, farm, and allied industrial equipment markets. BSAE or ME, or BS or MS in economics or agricultural economics. Age 25-35. Experience in economic or market research, sales engineering, or design in bulk materials, grain processing, or related equipment fields desirable but not essential. Desire to work in related engineering and market research. Must be aggressive, with initiative and ability to work with people. Potential for leadership and advancement. Salary open. O-158-821

AGRICULTURAL ENGINEER, associate professor or professor rating, for research (¾ time) and teaching (¼ time) in electric power

(Continued on page 316)

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Locke Steel detachable sprocket chain provides dependable power transmission and material conveying on the finest farm machinery

LOCKE STEEL DETACHABLE SPROCKET CHAIN

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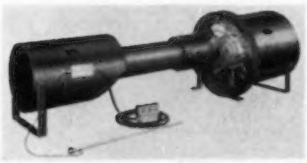
AUTO HUMIDITY CONTROL
DRY-O-MATION
NATURAL DRYING

DRY-O-MATION is DRYING IN STORAGE!
NO HANDLING— A Great Saving for the Farmer!



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With the DRY-O-MATION System of grain conditioning the supplemental heater attached to the fan automatically and instantaneously supplies heat to **maintain natural drying conditions that are always favorable.**

DRY-O-MATION assures uniform conditioning of **every** layer of grain in **every** part of the bin. Less shrinkage; no over-drying. Field-tested DRY-O-MATION makes the step from field to storage bin one continuous operation that saves time and money. It produces clean, premium quality grain every time. We cordially invite you to become fully acquainted with the simple, practical and low costing advantages of DRY-O-MATION. **Write us today for your free copy of the DRY-O-MATION Story.**

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ANNOUNCING

1958 ASAE Post-Convention Tours to Glorious HAWAII
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ASAE Members, Families and Friends
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(Made possible by pre-attached primary fastener)

RN NUT OHIO'S newest weld nut with pilot and dual-line projections. Ideal in applications where tension is against the weld.

WS NUT For applications on rugged assemblies where it is necessary to anchor nut securely in blind location.

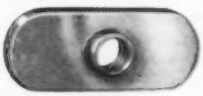
PN NUT Used where a pilot for easy locating, a strong weld and space limitations are important factors. Ideal for use in confined corners, flanges and narrow channels.

RH NUTS Used where it is desirable to have the body of the nut go through the sheet or where extra long thread engagement is needed.

WF NUTS Used where the nut serves a mounting purpose or greater thread engagement is required than is normally provided by other type weld nuts.

WW NUTS Used where a hermetic seal is required to prevent leakage of air, gas, water or dust on blind locations.

SN NUT Used where assemblies are being spotwelded together and a piloted nut is required.



ND NUT Used where a large nut is needed for bridging or joining two sheets or for extra strength.

OVER 50 YEARS OF BETTER FASTENING

Samples and information available upon request.

THE OHIO NUT & BOLT CO.
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(For more facts circle No. 32 on reply card)

. . . Events Calendar

(Continued from page 295)

July 20-26 — 15th Annual *National Farm Safety Week,* co-sponsored by the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill., and U.S. Department of Agriculture.

August 12-14 — *Cotton Production and Mechanization Conference,* Brownsville, Texas. Details may be obtained by writing Farm Equipment Institute, 608 S. Dearborn St., Chicago 5, Ill.

September 17-19—*Farm Materials Handling Conference,* Iowa State College, Ames, sponsored by American Society of Agricultural Engineers. For further details see page 130, March 1958 issue of AGRICULTURAL ENGINEERING, or write ASAE, 420 Main St., St. Joseph, Mich.

September 29 - October 1—*Farm Equipment Institute Convention,* Atlantic City, New Jersey. For information write FEI, 608 S. Dearborn St., Chicago 5, Ill.

September 29 to October 4 — *Fifth International Congress of Agricultural Engineering* to be held in Brussels, Belgium. The aim is to stimulate the science and the techniques of agricultural engineering, as well as the use of these techniques; and to coordinate scientific research and techniques in the fields related to agricultural engineering. Registration information may be obtained by writing to M. Nestor Laret, Avenue des Combattants, 69, Gembloux, Belgium.

October 5-7 — 5th Annual *National Power Use Conference,* Hotel Statler, Buffalo, N. Y. For details write Inter-Industry Farm Electric Utilization Council, Inc., P.O. Box 577, Washington 4, D.C.

October 19-22 — Annual Conference of the *Soil Conservation Society of America,* to be held in the Auditorium of Asheville, N. C. The theme is Land and Water for Tomorrow's Living. For further information contact SCSA, 838 5th Ave., Des Moines, Ia.

May 29 - June 7, 1959 — *RiLa* arranged by Swedish Federation of County Agricultural Societies and billed to be the largest agricultural show to be held in Sweden since 1946. Its aim is to give presentation of Sweden's mechanized farming and high-quality livestock breeding, and also the country's agriculture as an export-import industry. Further details may be obtained from The Swedish-International Press Bureau, Brunkebergstorg 14, Stockholm, Sweden.

. . . Membership Applicants

(Continued from page 313)

Kornegay, Robert C.—Student, North Carolina State College (Mail) R.R. 1, Smithfield, N. C.

Thompson, Ralph A. — Student, Virginia Polytechnic Institute (Mail) Box 5982, Virginia Tech. Sta., Blacksburg, Va.

Tyson, Elijah J. — Student, North Carolina State College (Mail) 122 34th St., NW, Hickory, N. C.

. . . Personnel Service

(Continued from page 314)

and processing, in an eastern state university. Age under 50. MSAE, or equivalent. Experience in responsible position on an agricultural engineering staff in public service or industry. Willing and able to show initiative, take responsibility, work with other staff members, and direct graduate students. Opportunity to take leadership in developing strong program of teaching and research in this field. Salary open. O-159-822

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, or research in farm structures with college, experiment station, manufacturer or consultant. Any location. Limited travel. Married. Age 24. No disability. BSAE, 1957; MSAE expected August, 1958, University of Maine. Summer work on forage handling equipment and in machine shop, mapping, and surveying. Graduate assistant in teaching and research in farm structures field. Available September 1. Salary open. W-25-20

AGRICULTURAL ENGINEER for teaching service courses to vocational agriculture students, college level. Midwest. Married. Age 42. No disability. BSAE, 1948; MSAE, 1953, University of Missouri. Farm background. High school teacher and principal 4 years. College teaching of agricultural engineering service courses 10 years. War enlisted service in Air Corps 3½ years. Available July 1. Salary open. W-127-21

AGRICULTURAL ENGINEER for development, research or extension in farm structures or product processing with college, experiment station, manufacturer, processor, or trade association. Any location. Limited travel. Married. Age 22. Subject to asthma. BSAE, 1957, MSAE expected in August 1958, Purdue University. Major in processing. Farm background. Summer work experience as construction hand, factory worker, and student engineer. Available in August. Salary open. W-128-22

AGRICULTURAL ENGINEER for design, development, or research, soil and water field, industry or public service. Warm dry climate preferred. Willing to travel. Married. Age 31. Wear glasses. BSAE, 1951, Michigan State University. SCS, USDA six years as area engineer (10 county area), in drainage. Some work in small erosion control structures, ponds, flood control, and irrigation. War enlisted service 1½ years in Signal Corps. Available on 30 days notice. Salary $7000-8000. W143-23

AGRICULTURAL ENGINEER for design, development, research, teaching, sales, or service in power and machinery or product processing, public service or industry, anywhere in the USA, or in Central or South America or South Pacific area. Married. Age 34. No disability. BSAE, 1949, University of Idaho. Design, field test, and supervisory experience 4 years with major full line farm equipment manufacturer. Design of crop dusters, one year, with specialized equipment manufacturer. Taught agricultural engineering in college one year. Shop supervision, shop work, and design with specialized farm equipment manufacturer one year. With consultant 2 years on design, layout, and field testing of farm and construction equipment. War enlisted service service in clerical work 2 years. Available June 1. Salary $9000. W-181-24

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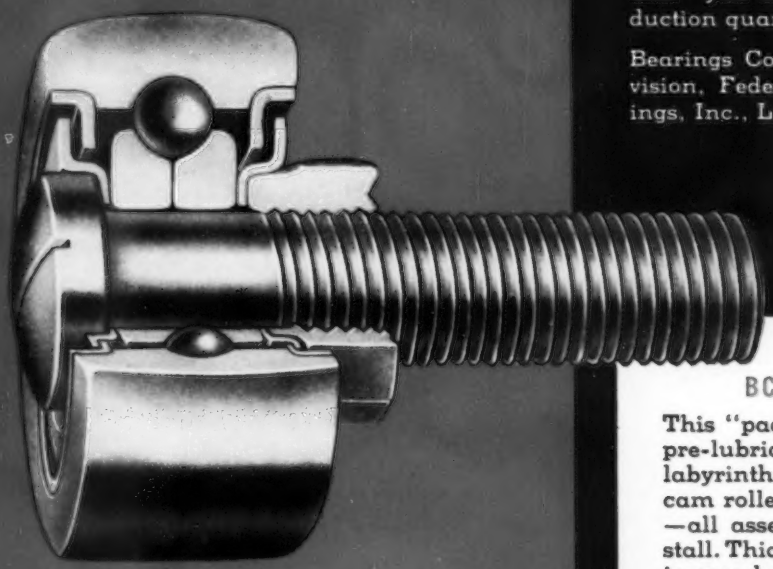
BCA makes a complete line of ball bearings for agricultural applications. We will also work with your engineers on ball bearing design problems . . . to make the "package unit" you need, in sample or production quantities.

Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.



BCA CAM FOLLOWERS

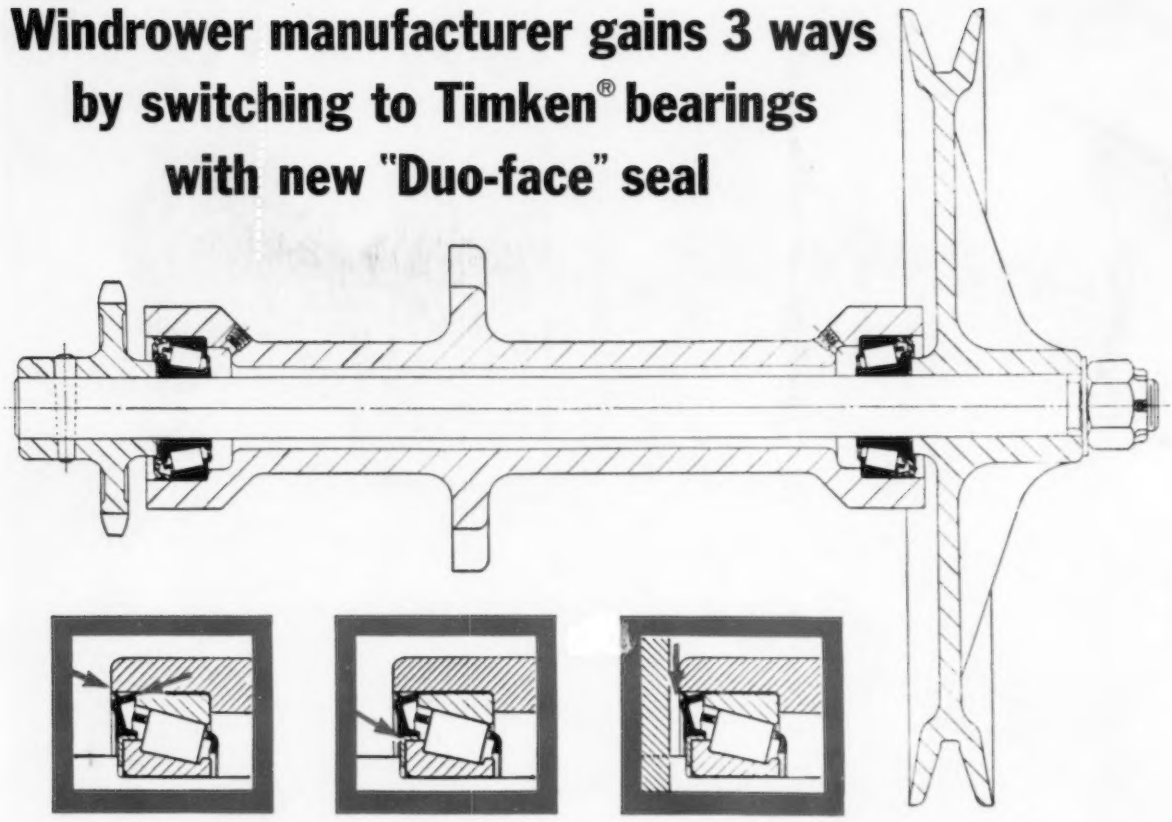
This "package unit" includes pre-lubricated bearing—either labyrinth or contact, seals, cam roller and mounting stud—all assembled, ready to install. Thick sectioned outer race is case hardened to withstand shock and is slightly crowned to assure better contact with cam. 37 different designs are available, with labyrinth or contact seals, to meet your "package unit" needs.

BCA

BEARINGS COMPANY OF AMERICA
DIVISION OF
Federal-Mogul-Bower Bearings, Inc.

(For more facts circle No. 26 on reply card)

Windrower manufacturer gains 3 ways by switching to Timken® bearings with new "Duo-face" seal



1. Gets 2-way sealing
New Timken bearing Duo-face seal seals against both the bearing cup face and housing bore.

2. Cuts installation costs
Nothing to assemble. Duo-face seal comes pressed on the cone as a unit assembly.

3. Saves space
Seal adds practically nothing to the width of the bearing.

INTRODUCED only four months ago, Timken® bearings with the new "Duo-face" seal are going into more and more farm machines as major implement manufacturers switch to this new bearing-seal unit. The large diagram shows how one manufacturer uses it on the platform drive of a self-propelled windrower. The small diagrams show how he saves three ways.

1. GETS 2-WAY SEALING. The new Duo-face seal is the only anti-friction bearing seal having the combined advantages of an O.D. and a face type seal. One lip operates against the bearing housing bore, providing an O.D. seal. The other against the smooth, flat, hardened surface of the bearing cup, providing a face type seal.

2. CUTS INSTALLATION COSTS. Factory assembly of the seal on the cone ends mounting of the seal and bearing in separate operations. It eliminates special handling and assembly problems. There's no need for special tools or fixtures. No extra installation costs. And there's less chance of damaging the seal when removing it from a machine.

3. SAVES SPACE. Less space is needed for the new Duo-face seal than for conventional seals. This permits more compact hub and housing designs yet does not limit lubricant capacity.

The Timken Company Duo-face seal has been field-tested and proved on self-propelled windrowers, tractor front wheels, implement wheels, disc jointers, disc harrows, coulters, side-delivery hay rakes and conveyor idlers. Timken bearings with assembled Duo-face seals are available in the following bore sizes: .7500″, .8437″, 1.0000″, 1.2500″, 1.3750″, 1.5000″ and 2.6875″. For information, call your nearby Timken Company sales engineer, or write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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The farmer's assurance of better design

Tapered Roller TIMKEN BEARING EQUIPPED

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